1989

Late Archaic Landscapes

Stephen Howard Savage

Glen T. Hanson

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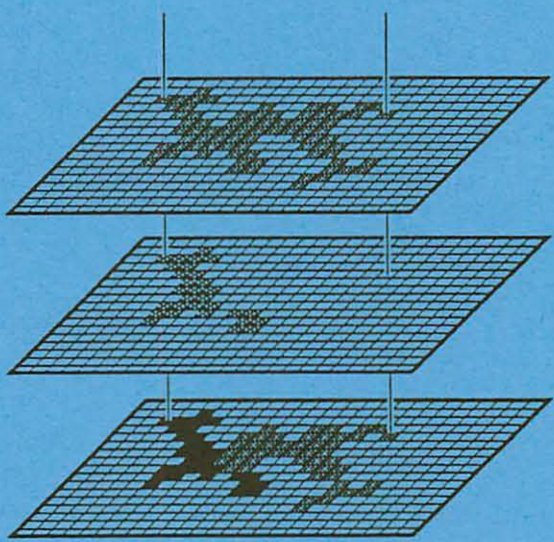

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LATE ARCHAIC LANDSCAPES

A Geographic Information Systems Approach To the Late Archaic Landscape of the Savannah River Valley, Georgia and South Carolina

by

Stephen Howard Savage

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ABSTRACT

Traditional research into the Late Archaic period in the Southeastern United States has focused on matters related to subsistence and procurement, carried out under such paradigms as Cultural Ecology, Optimal Foraging Theory, and settlement/subsistence studies. The Landscape Archaeology approach is able to unify a number of these traditionally separate avenues of research into a holistic approach, while incorporating recent revisionist models such as Social Territories, Boundary/Center studies, and the dialectic between the physical/cultural landscape and individual perceptions of it. When the Landscape Archaeology approach is operationalized through Geographic Information Systems methodology, a truly powerful theory and method may be applied to the study of past cultural systems. Here, that combination is used to explore the existence of Late Archaic maximum band social territories and minimum band subsistence territories (Habitual Use Areas) in the Savannah River Valley of Georgia and South Carolina.

PREFACE

The volume presented here was submitted by Stephen Savage as part of the requirements for the degree of Master of Arts in the Department of Anthropology at the University of South Carolina. Stanton Green was the director of the thesis, with Albert Goodyear of the South Carolina Institute of Archaeology and Anthropology being the second reader, with David J. Cowen, of the Department of Geography being the third reader. The fourth reader was Michael Allen Hoffman of the Earth Sciences and Resources Institute.

Funding for the publication of this volume in the *Anthropological Studies* series was provided by Bruce E. Rippeteau, Director of the South Carolina Institute of Archaeology and Anthropology. As editor of the series I am pleased to have a part in the publication of this volume.

Stanley South, Editor
Anthropological Studies Series
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Archaeology and Anthropology

ACKNOWLEDGMENTS

A project of this magnitude cannot be accomplished without the help and advice of many individuals. At this time, I would like to thank all those who assisted me in its completion.

First, I would like to thank the members of my committee for their assistance, individually and collectively. Without their input this project could not have been completed in the form in which it is presented. I have attempted to take all of their suggestions to heart in the research and write-up. Naturally, any shortcomings in this document are entirely my own.

Dr. Stanton Green first spurred my interest in Geographic Information Systems. When I was looking for a computer mapping course to take, he suggested Dr. David Cowen's course in GIS, and sat in on it with me. Our understanding of the possibilities for GIS in archaeological research has developed through this thesis and our efforts to create a geographic information system for Stan's ongoing Bally Lough Archaeological Project. Stan helped me with the form and content of each chapter, especially with Chapters II and V, which contain the heart of the thesis. Much of the final approach that this thesis takes is thanks to his efforts as Thesis Director.

Much thanks is due to Dr. David Cowen, teacher of the course in GIS and Director of the Humanities and Social Sciences Computing Lab. The GIS class proved to be exactly what I was looking for, and methods of applying GIS to archaeological research developed as part of the class work have been a tremendous help in this thesis. In addition, Dave provided two personal computers to the Department of Anthropology, and made operating space on a number of systems in the Lab. The maps presented in this thesis were printed on a Calcomp Printronics thermal printer (in the color versions), and the HSSCL's electrostatic plotter (for the black and white versions), made available to me by Dr. Cowen, and his advice on GIS techniques contributed greatly to their final form.

Dr. Albert Goodyear of the South Carolina Institute of Archaeology and Anthropology deserves much thanks for his expertise in the prehistoric Southeast. Many discussions of the nature of the Late Archaic period found their way into this thesis in one form or another. Al first suggested that I use the data from the Richard B. Russell Reservoir project for this thesis, and his familiarity with it was of great help during the analysis phase of this project.

Dr. Michael Hoffman of the Earth Sciences and Resources Institute provided me with his expertise in the southeastern Late Archaic, and provided a sounding board for discussions on the relationship between anthropology and archaeology, as well as the early philosophical development of anthropology and geography. I hope to apply what I've learned at Hierakonpolis, Mike!

In addition to the members of my committee, I would especially like to thank Dr. Joan Gero for her thought provoking (and noteworthy) classes, The Development of Anthropological Archaeology and Current Issues in Archaeology. Much of the theoretical perspective taken in this project is due to her excellent teaching. In particular, I am grateful for her early suggestions for Chapter II, and for helping me trim this project down to a barely manageable size.

Thanks are due to Lynn Shirley, Tim White, Homer Steedly, Eddie King and Fariborz Babaee of the Humanities and Social Sciences Computing Lab for providing much needed hardware and software support. I could not have done it without their efforts, and I apologize for all the times I bothered you all when you were otherwise occupied. Also, I would like to thank Stan Larimore of the USC Computer Services Division for providing the digital elevation data used in this project.

Nena Powell and Keith Derting of the South Carolina Institute of Archaeology and Anthropology were a great help. Nena helped me with research at the S.C.I.A.A. library, and Keith provided site forms and UTM's from the Institute site files.

Renie Counts of the Computer Services Division instructed me on the operation of slide-making equipment, and put up with my occupying her office for hours and days on end while I made slides for presentations of this thesis research.

Claudia Green is the only "survivor" of the original Richard B. Russell survey crew still in the area, and was able to tell me much about the operation of the project.

Thanks are due to all those who provided me with papers on their applications of GIS methods to archaeological research. Among these are James Farley, Kenneth Kvamme, Bryan Marozas, Robert Warren and Ezra Zubrow.

Thanks to Natalie, Rick, Kathy, Robin, Jim, Mike, Linda, Roy and Ruth!

Last, but certainly not least, I would like to thank my wife, Kim, for her patience and support during the past two years, and for editing the final copy of this thesis. I certainly could not have completed this degree without her. Surely the best is yet to come!

To the Memory of my Father,

Orville L. Savage (1924-1988)

a painter and planter of landscapes.

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CHAPTER I

INTRODUCTION: TOWARDS A NEW COMBINATION OF THEORY AND METHOD

LANDSCAPE ARCHAEOLOGY

Archaeologists have gained many valuable insights into human adaptation and the human past through the study of settlement, subsistence, demography, ecology, material culture, and, to a lesser extent, social organization. This thesis offers Landscape Archaeology as an integrative paradigm for studying past cultural systems that incorporates many traditional approaches. Landscape Archaeology offers a holistic view that places individuals and individual behavior at the center of research. Past human culture is studied in terms of the physical, material, and cognitive ways humans inherit, transform, and bequeath their natural and cultural environments.

Models of locational choice, for example, consider site location in terms of information and action, and recognize the contradiction between the two, and among the perceptions of individual members of a society. Models of social organization can be conceptualized in terms of the social, cognitive, and physical landscapes within which people live. The remains of past cultural systems are left scattered about in all three landscapes.

Similarly, models of differing modes of subsistence, of different settlement and site types, and of different collecting strategies, to name but a few, can be studied under the general umbrella of Landscape Archaeology. Each activity associated with such models produces patterned remains in the archaeological record that can, if studied as a landscape, tell us much about the ways people in the past viewed and used their world.

Landscape Archaeology can provide powerful insights into the way past societies found, transformed, and passed on their physical and cultural surroundings, and can be shown to unite many of the issues and phenomena currently studied under different paradigms. Virtually all of human behavior results in patterning in the physical, cultural, or cognitive landscapes, and is, therefore, amenable to studies informed by Landscape Archaeology.

This thesis uses Landscape Archaeology to bring several diverse approaches to the past together in a study of social organization in the Late Archaic in the Savannah River Valley of Georgia and South Carolina (Figure 1). The approaches of Geographic Location Theory, and models of social space, subsistence, site type, and collecting strategies are discussed in Chapter II. In this chapter, I discuss issues concerning the social landscape of the Late Archaic as it related to subsistence and technological changes observed during this period. That Late Archaic peoples ate shellfish is important to the extent that such information can be brought to bear on the more important social issues such as developing status differentiation, warfare, and trade.

GEOGRAPHIC INFORMATION SYSTEMS

As the title of this work suggests, this thesis relies on the particular methodological approach of Geographic Information Systems (GIS). The use of GIS in archaeological research is a recent phenomenon; many archaeologists are still unfamiliar with the basic types of systems available, and the ways other archaeologists have used them. Chapter III will discuss both of these subjects.

A GEOGRAPHIC INFORMATION SYSTEMS APPROACH TO THE LATE ARCHAIC LANDSCAPE OF THE SAVANNAH RIVER VALLEY, GEORGIA AND SOUTH CAROLINA

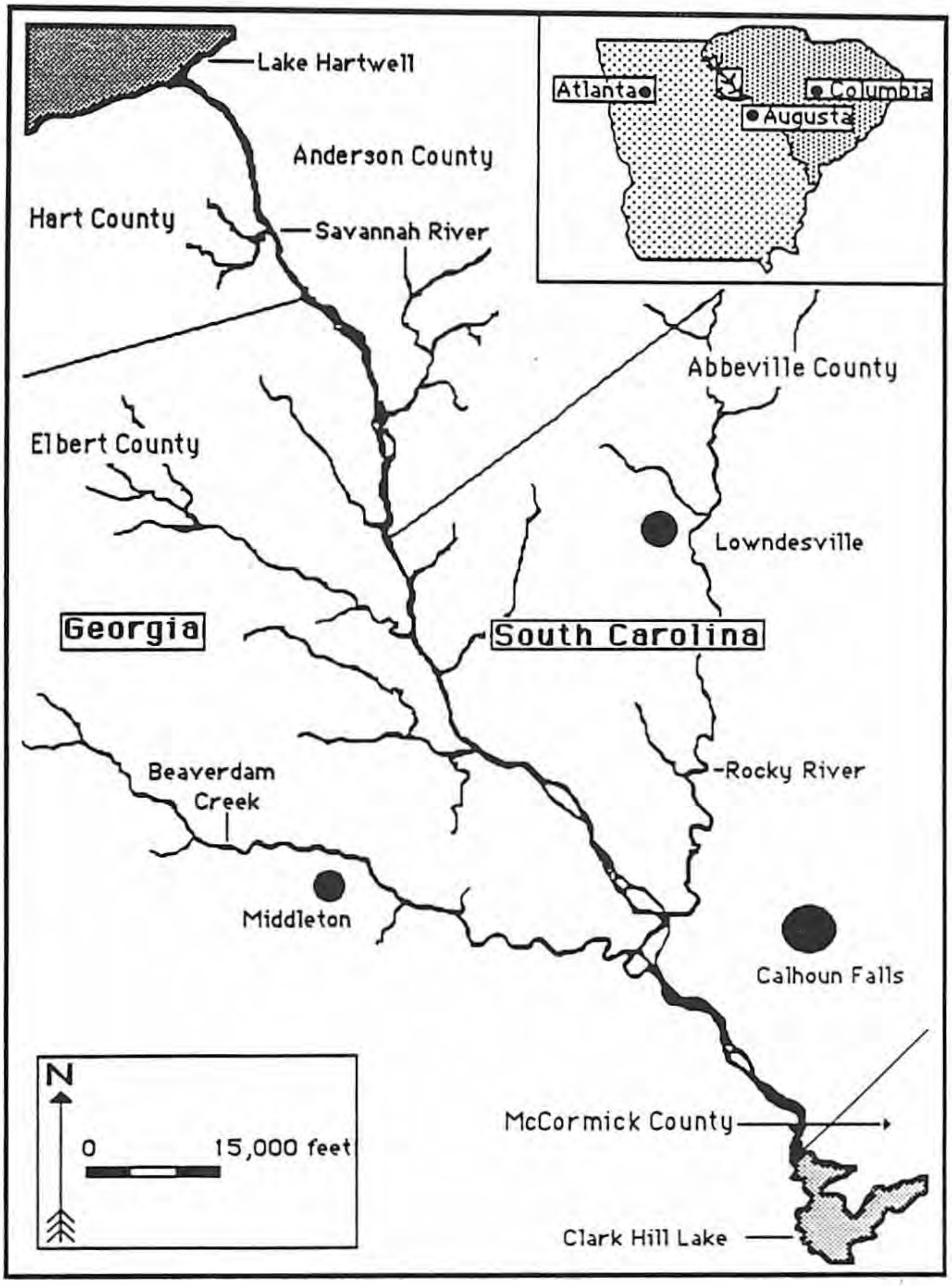


Figure 1. Project Area Before Inundation.

Geographic Information Systems present a powerful method for developing and testing theories related to Landscape Archaeology. Traditional approaches to the study of the archaeological axes of form, space, and time have not been able to successfully cope with all three simultaneously. Analytical methods such as spatial autocorrelation and the mapping of principal components have not been able to provide understandable answers to the questions asked of them.

The development of GIS promises to provide much more effective means to control all three archaeological axes. In GIS, all data are spatially referenced. Data representing form and time may thus be analyzed through mathematical or Boolean techniques in a manner that preserves their location. The interplay of GIS methods and Landscape Archaeology presented in this study clearly shows the power of this new combination for future archaeological research.

THE DATA SET AND HYPOTHESIS

The data set used in this study was first reported as a part of the archaeological survey of the proposed Richard B. Russell Reservoir (Taylor and Smith 1978). Fifty-one Late Archaic sites are used to test the hypothesis that Late Archaic social organization consisted of maximum band social territories and minimum band subsistence territories. The project area, and the archaeological survey that collected the data, are described in Chapter IV. The hypothesis, bridging arguments, and test implications are presented in Chapter V, as are the results of testing procedures. Both statistical and GIS methods are used to assess the validity of the test implications.

SUMMARY

This thesis is concerned with two primary goals. As an anthropologist, I am concerned with people and society, and cultural change. These are what make the Late Archaic interesting. My primary goal is to develop an understanding of Late Archaic social organization that will provide a framework for studying the tremendous social and technological changes attending the period.

Second, I am interested in the development of a GIS-based methodology that can work hand-in-hand with a powerful body of anthropological theory to provide new avenues of research into past cultural systems. The Geographic Information Systems approach to the Late Archaic landscape has been extremely productive in reaching both of these goals.

CHAPTER II

A CRITICAL REVIEW OF MODELS USED TO INTERPRET THE LATE ARCHAIC IN THE SOUTHEASTERN UNITED STATES

INTRODUCTION

Most of the research into the Late Archaic (5,000 BP to 3,000 BP) in the Southeastern United States has centered on issues related to subsistence and maintenance activities -- what did Late Archaic peoples eat and where did they go to get their food? What raw materials did they use? Where did they get them? Most of the models that have been constructed to answer these (and similar) questions can generally be placed in three broad categories: 1) models based on the nature of resource collection, such as Caldwell's "Primary Forest Efficiency" (1958) or Cleland's "Focal/Diffuse Model" (1976); 2) maintenance/extraction models (Binford and Binford 1966); and 3) Optimal Foraging Theory (Keene 1981a, 1981b, 1983). Other more specific Late Archaic land use models have been proposed for the Southeast, but they are based on insights drawn from these three main classes.

Archaeologists have come to view the Late Archaic, though, as a period of significant change in southeastern North America. These changes include the development of social hierarchies, as evidenced by the differential age/sex based internment of grave goods at Indian Knoll (Webb 1946) and Eva (Lewis and Kneberg-Lewis 1961; Bender 1985b). Long-distance trade results in the exchange of Great Lakes copper for Southeastern coastal shells (Bender 1985b; Marquardt 1985). Increasing territoriality may have led to warfare among different groups (Ford 1974; Steponaitis 1986; Webb 1946).

Attending these social changes are technological changes such as the development of ceramics along the coasts of Georgia, South Carolina and Florida (Claflin 1931; Phelps 1965; Stoltman 1972; Trinkley 1980), and the beginnings of horticulture (Marquardt and Watson 1983, 1976; Marquardt 1985).

Unfortunately, the models which have been developed to explain the Late Archaic seldom address issues related to these significant areas of social and technological change. It is the social and technological issues that make the period interesting to me -- not that Late Archaic people ate deer and shellfish. But much that has been written in the past thirty years is dependent on Caldwell's interpretation of the period, and his work was centered on subsistence. Optimal foraging models have been constructed, but these attempt to answer questions related to obtaining the "minimum daily adult requirements of ten essential vitamins and iron", and do little to address broader questions of social organization or change. Some modifications to optimal foraging theory have taken place, but these generally bicker over the relative importance of various ecozones to the Late Archaic subsistence scheme, and, again, do not address the interesting issues. Optimal foraging theory, indeed, continues to drive much of the prehistoric research conducted in the Southeast (e.g. Anderson and Hanson 1988).

There are encouraging developments, though. Revisionist approaches stressing the role of information as "currency" in the Late Archaic have been suggested by Root (1983) and Moore (1983). Social relationships may be seen as resulting from the "exchange" of such "currency". The work of Green and Sassaman (1983) and Sassaman (1983) suggests that the changes which accompanied the Late Archaic must be viewed in terms of an active political economy. Their work, though, while emphasizing the importance of linking the political economy to subsistence and social organization, continues to speak principally in terms of subsistence related activities and seasonal rounds adjusted to the collection of resources.

Other revisionist approaches include the works on social territories by Clark (1975), in which four levels of social organization are postulated; that of Wobst (1974), where a simulation study of minimal and maximal band sizes suggests insights into social patterning and mating rules; and those of Marquardt and Crumley (1987) and Perlman (1985), where the dynamics of boundaries between social units are explored.

In this thesis I aim for a target beyond these beginnings, though drawn heavily from the more recent revisionist approaches. Following Conkey (1988), I will "advocate using archaeological evidence to elucidate strategies of social action, of social formation [and] of social production . . ." I will concentrate especially upon Landscape Archaeology, spatial organization, and the role of Geographic Location Theory (Pred 1967) and Geographic Information Systems in understanding how space is used to create and modify such strategies of social action.

> As many geographers would argue, there is always a whereness to meaning-making and experience, and to power -- a spatial frame. Although we, as archaeologists, should be overwhelmed by the spatiality of our data (archaeological sites) and of our theory -- to the point of participating in/contributing to the anthropological problematic of spatializing time and producing a past in a spatial metaphor -- there still is the spatial dimension -- the whereness -- that could be one frame through which we might view the historical production and reproduction of the social formations we wish to explain [Conkey 1988].

Rather than view the Late Archaic as a continual quest for food, I believe that we should be addressing the larger issues -- how were people organized? How were the social relationships negotiated between and among groups? I view the archaeological record as the material and spatial correlates of human decision making processes -- of human interactions with each other as well as with the environment. This spatial process takes place within an active political economy. A body of theory with more power to explain such phenomena is called for.

We should not be surprised to find that geographers, whose primary study is space, have developed a body of theory that allows for this kind of investigation. Twenty years ago geographers such as Pred (1967) were developing and critiquing models of human/environmental spatial interaction that have yet to be adopted by archaeologists, even in their quest to understand essentially the same phenomena. I will draw upon this body of theory in an attempt to address social issues related to the use of space in the Late Archaic.

This chapter will examine the various models of Late Archaic subsistence and settlement that have been applied in the Southeast. I will begin by looking at the seminal work of Caldwell (1958), and Cleland (1976), followed by that of the Binfords (1966). Optimal Foraging Theory will be examined in detail, since it appears to provide solutions to subsistence related questions, but, in reality, may be seen to present a solution that is at once both too complex and too simple to address even these issues, let alone larger questions related to social organization. I will follow this discussion with a review of the revisionist approaches of the last few years, in particular as they can be seen to lead into an exploration of Geographic Location Theory and Landscape Archaeology.

Specific Late Archaic settlement/land use models have been proposed in the Southeast, drawn out of the more general research trends already mentioned above. I will review these in terms of the larger models upon which they are based.

This chapter will introduce a solution to the problem of addressing what Conkey (1988) has called the "whereness to meaning-making and experience, and to power", the spatial frame, by discussing the role of Geographic Location Theory, and its ability to place spatial information in the center of an active political economy.

Finally, I will explore some of the recent works dealing with social organization and boundary zones, and will use Landscape Archaeology as an overarching approach which can pull many pieces of theory into a coherent whole. Landscape Archaeology can be shown to unite Geographic Information Theory, models of social organization such as Clark's (1975) and Wobst's (1974), boundary models such as those of Green and Perlman (1985) and Marquardt and Crumley (1987), subsistence,models of site type such as the Binfords' Maintenance/Extraction Model, and models of logistic or forager movement. By uniting these disparate themes, Landscape Archaeology emerges as a powerful paradigm for understanding the actions of people in their physical and cultural environment.

THE FOUNDATIONS OF LATE ARCHAIC SETTLEMENT/LAND USE MODELS

The works which I will discuss in this section may be thought of as seminal, since many of the more specific settlement/land use models created to explain the Late Archaic in the Southeast have drawn upon them in various degrees. These include Caldwell's "Primary Forest Efficiency" (1958), which I regard as the progenitor of subsistence studies in the Southeast, Cleland's "Focal/Diffuse Model" (1976), which revises and expands Caldwell, the Binfords' "Maintenance/Extraction Model" (1966), which reminds us to consider site function in a settlement scheme, and the optimal foraging models produced by researchers such as Jochim (1976) and Keene (1981a).

Primary Forest Efficiency

Thirty years ago Joseph Caldwell published his seminal work, Trend and Tradition in the Prehistory of the Eastern United States (1958). He discussed the continuing adaptation of aboriginal peoples to the eastern woodlands environment, culminating in the Late Archaic with an extremely well adapted subsistence pattern which he called "primary forest efficiency" (1958:6), and described as:

> . . . an increasing efficiency in exploiting the forest, manifested in the development of ambush hunting, seasonal cycles, and the discovery of new sources of natural foods. This trend was progressive in the sense of being an increasingly successful adjustment to the eastern forest environment, at the beginning of the second millennium B.C., in what we have called the establishment of primary forest efficiency. As a result, peoples in the areas of more abundant food resources achieved a degree of residential stability [1958:vii].

Under this rubric, increased efficiency allows for population growth, relative settlement permanence within generally well-defined territories, an increase in material goods made possible by sedentism, and the beginnings of ranked society based on differential access to trade items and the unequal accumulation of goods. Seasonal rounds were worked out that allowed populations to exploit the most productive resources at the best times of the year. Groups may be seen moving into various ecological niches throughout the year, for example, into the uplands during the fall, to harvest the abundant forest mast and the deer that feed on it, and back to the floodplains during the late winter and early spring to take advantage of the anadromous fish runs in the major river systems.

Caldwell's work lies at the beginning of much that has been done since. His work lies at the base of most of the Southeastern research in the Late Archaic, and lays out the fundamental approach, assumptions, and foci for the research which followed. Later in this paper I will discuss optimal foraging theory in greater detail, but I wish to point out here that the beginnings of its use may be seen in Caldwell's "primary forest efficiency". When Caldwell described the working out of seasonal rounds that allowed population growth and cultural diversity, he was describing a process that would later be operationalized and formalized (borrowing from biology) by Keene, Jochim, Winterhalder, Smith and others as optimal foraging theory.

The Focal-Diffuse Model

Writing much more recently, and incorporating a vocabulary drawn from ecological anthropology and energy theory, Cleland (1976) expands on Caldwell's work through the development of a "focal-diffuse" model of prehistoric subsistence. The model is based on adaptation of groups to cyclical resource availability within their foraging range, and is keyed to producing maximum energy gains for minimum energy expenditures. The focal-diffuse model is described as:

> An adaptive strategy -- [where] a series of alternative choices involving energy expenditure relative to expected energy gain -- develops to secure this energy requirement. In formulating such a strategy, the only predictable variables are a knowledge of the productive capability of the group based on known technological and social factors, and, importantly, the knowledge that the rhythms of nature are regular. Any adaptive strategy is based on the assumption that particular resources are available in known quantity.
>
> Finally, adaptive systems are assumed to be constantly evolving -- a process motivated by the continuing search for economic security and directed by shifts in the choices incorporated into the adaptive strategy. . . . The search for economic security ultimately tends to move adaptive patterns from less productive to more productive in terms of input-output energy ratios, and thus adds direction to the adaptive process [1976:60].

Several new elements are added in Cleland's work. Most notable is the adaptation jargon drawn from the New Archaeology's preoccupation with that phenomenon as the definition of culture, operating extra-somatically. The use of energy as a scale for determining success or failure of the particular adaptation formalizes the connection between the New Archaeology and the entropy models of Leslie White (1959). Energy becomes the currency. Its accumulation and wise investment mark the society thought to be the best adapted to its environment. Cleland presents a continuum of adaptive strategies, ranging from a focal adaptation keyed to maximizing a few resources, to a diffuse strategy based on "the scheduled utilization of a great variety of resources" (1976:60).

> The economy of people with diffuse adaptations is based on the careful scheduling of exploitation, so that the natural availability of resources is maximized and so that alternative resources are available. The key to such an adaptation is movement between resources in time and space [1976:64].

The diffuse end of Cleland's continuum is a restatement of primary forest efficiency. Where Caldwell speaks of "the discovery of the times and places where wild foods were most effectively secured" (1958:12), Cleland refers to the maximization of resources in time and space. While Cleland's emphasis on energy gains and adaptation is in line with the developing optimal foraging theory, his diffuse end of the focal-diffuse continuum is essentially the pattern that Caldwell described thirty years ago for the Late Archaic.

Caldwell's model is based on an assumption of progress, where a series of adaptations culminates in the adaptation of primary forest efficiency. To label as "efficient" one adaptation is to imply that other, previous adaptations were not. Cleland's focal-diffuse model, on the other hand, allows us to consider all such societies as equally "efficient" on their own terms, while at the same time recognizing the varying breadth of their environmental exploitation.

The Maintenance/Extraction Model

Binford and Binford (1966) postulated that there should be observed differences between sites occupied for base camps and maintenance sites, and those which represent extractive locales.

> For technologically simple societies we can distinguish between two broad classes of activities: extraction and maintenance. Extractive activities are those that center around the direct procurement of subsistence items or of raw materials to be used in the manufacture of artifacts. Maintenance activities are related to the preparation and distribution of subsistence goods already on hand and to the processing of on-hand raw materials in the production of tools. The distribution of resources in the environment bears no necessary relation to the distribution of locations affording adequate life-space and protection, and we would therefore expect differential distribution in the territory of a group of locations for extractive and maintenance activities. We would expect there to be base camps selected primarily in terms of adequate life-space, protection from the elements, and central location with respect to the distribution of resources [1966:268].

Extractive sites, though, should be located at or near the locations of resources, in the case of stationary items such as lithic raw material or forest mast. Kill sites and butchering stations will be located at the point of contact with the mobile resource. Some sites, such as fish weirs, will be permanently located, but will be used in the extraction of a mobile resource.

Maintenance and extractive activities, however, do not have to be mutually exclusive. Extractive activities can occur at or near base camps, especially if the camps are located in rich ecozones or on ecotones. Alternatively, what we interpret as a base camp may be a palimpsest of short extractive episodes, where different resources were extracted at different times, each leaving its telltale artifactual debris. When viewed synoptically, such activity may be interpreted as a maintenance area. Some base camps may be located in areas where temporary resources are extracted. For example, it may make sense to move the base camp into the uplands during the fall deer exploitation season, so that transport costs may be reduced when deer are killed at remote sites. Despite these difficulties, other researchers in the Southeast have made use of this work in creating predictive models of site location (e.g. House and Ballenger 1976).

Optimal Foraging Models

The use of optimal foraging models provides a mathematical, and presumably empirical, basis for examining questions related to subsistence and settlement in the Late Archaic: What did (or should) people eat? How to schedule for getting the various foods? Optimal foraging theory provides answers in the form of idealized strategies for maximizing energy inputs and minimizing outputs.

Optimal foraging theory presents a set of models developed primarily in the biological sciences, and applied to hunter-gatherer groups by archaeologists (Winterhalder 1981; Smith 1981; Keene 1983; Jochim 1976). They are based on principles of evolutionary ecology:

> Optimal foraging models are based on the neo-Darwinian assumption that natural selection and competition are the inevitable outgrowth of reproduction in a finite environment. Natural selection will favor foraging behaviors that result in maximum fitness with regard to whatever constraints are operating. In other words, there will be differential survival of those behaviors which best allow an individual or population to achieve its life goals in a specific environment [Keene 1981a:8].

The general models that have been adapted by archaeologists were created by biologists and evolutionary ecologists to explain behavior in animal populations (Yesner 1981). For example, Heffley (1981) creates a model of the relationship between Athapaskan settlement patterns and resource distribution based on a biological model developed by Horn (1968) to explain colonial nesting in Brewer's blackbirds. Zubrow (1972) has made use of the concept of "carrying capacity", a model derived from the management of white-tailed deer herds (McCullough 1984) and Malthus' work on population dynamics. In these applications, an analogy is drawn between groups of aboriginal foragers and animal populations with adaptation, or survival, being the test of strategy effectiveness.

Generally, three areas of research are explored through optimization models: food choice and dietary components, group size and demographics, and site location/patch use (Keene 1981a; Winterhalder 1981). Regardless of which area is addressed, the researcher attempts to find the "best", or optimal, solution applicable to a specific group within a specific environment. The best solution is defined in terms of an energy "currency" (recall Cleland's vocabulary in describing his focal-diffuse model). Solutions that maximize energy inputs and minimize outputs, producing minimum entropy (White 1959), are judged to be "best", or optimal (Bettinger 1987), and are therefore judged to have the greater survival potential.

Keene's (1981a, 1981b) study of prehistoric foraging in the temperate forests of Michigan may be used as an example of the optimal foraging approach. He addresses the questions of diet composition and patch location based on known and projected minimal caloric and vitamin/mineral requirements for individuals. A linear programming approach allows all the various parameters to be considered in determining an optimal solution. The linear programming model requires a specific goal be declared, against which the program weighs all the available data, varying combinations of inputs in order to approximate the goal. Following the basic trend of other archaeologists, Keene chose energy maximization as his goal.

However, because of the limited set of subsistence-related issues capable of being addressed by optimal foraging theory, several of the researchers (Keene 1983; Jochim 1983; Moore 1983) who were prominent producers of subsistence models based on this approach have begun to have doubts about the long-term effectiveness of its use. Here I will briefly review some of their concerns, as well as issues that have arisen in part because of the advent of "Post-Processual" archaeology (Hodder 1985).

Optimal foraging models were borrowed from the biological sciences, and much of the biological basis for the models was translated into a social vocabulary. For example, ". . . we see the equation of mutation with invention, gene flow with diffusion, gene pools with arrays of cultural behavior, mating with marriage, dominance with social class, and biological reproduction with social reproduction" (Keene 1983:141).

The literal borrowing and transformation of basic biological concepts into sociological concepts may not be legitimate. Can the behavior of people, in a social and cultural environment, really be compared with Brewer's blackbirds (Heffley 1981)? Other social or cultural variables, which cannot "easily" be transformed into biological concepts, are factored out of consideration.

Thus, questions of leadership, personal initiative, information exchange, and social relations cannot be considered. Hodder interprets culture as "meaningfully constituted" (1986), but rather than providing meaning, optimal foraging theory ignores many of the factors that have the most power to explain cultural phenomena. ". . . social causality and social complexity get approximated away because they are outside the set of behaviors that humans share with other animal populations" (Keene 1983:141). Yet it can be argued that the explanation of social causality and social complexity are the ultimate goals of anthropological archaeology. Approaching such explanations through the use of Geographic Location Theory and Geographic Information Systems is the goal of this thesis.

Another problem with optimal foraging theory is its tendency to examine "optimal", or modal, behavior. Adaptations are not geared to the high or low points in environmental cycles, but to an idealized middle ground that does not always exist in nature; no process is presented for coping with such environmental fluctuations.

For example, deer herds are known to experience population "crashes" as a result of diseases, environmental perturbations, and the like (Verme and Ullrey 1984; McCullough 1984; Matschke, et al. 1984). Methods of calculating optimal foraging strategies that include deer do not take such population variation into account. Applying a linear programming model (Keene 1981a) to predict optimal behavior assumes a constant rate of recruitment.

The use of linear programming as an appropriate technique for creating optimal foraging models does not appear to be valid in light of recent studies related to non-linear, chaotic systems (Gleick 1987; Lorenz 1963, 1979; May 1974, 1976; May and Oster 1976; Campbell, et al. 1985). The weather follows non-linear patterns; plant growth, therefore, follows non-linear cycles. Animal populations dependent on plants must also follow non-linear recruitment patterns, and predator populations in turn depend on the abundance of prey species.

The non-linear nature of plant and animal recruitment implies that understanding prehistoric foraging in terms of optimization is not only more complicated than we have imagined, but possibly more complicated than we are able to imagine. Linear programming simplifies reality; the real world is so dissimilar to our models that the approach may not be a worthwhile technique.

Moore has also pointed out that optimization models simplify reality, whether they take a linear programming approach or not:

> . . . it is worth noting that optimization approaches to individual behavior are models, and like all models, they make the complexity of the world understandable by presenting us with simplified and incomplete versions of that complexity. The simplifying assumptions granting omniscience, errorless and infinitely rapid calculation abilities, as well as freedom from social or cultural constraints to the decision maker, elevate cost-benefit evaluation to the position of a cultural universal. They rob our decision makers of any social or cultural context [1983:175].

While the non-linear nature of ecological systems and the simplifying behavior inherent in our optimal foraging models implies that much more has to be considered in order to approximate the complexity of the real world, Jochim (1983) and Simon (1959 in Pred 1967) raise the point that most human decision making is actually much <u>simpler</u> than our models:

> Real decisions are usually shortsighted approximations, characterized by restricted knowledge, faulty perceptions, and limited calculating abilities. The complex mathematical features of optimization models result in a decision making structure quite different from the actual processes of decision making that people use [Jochim 1983:159].

> The capacity of the human mind for formulating and solving complex problems [locational or otherwise] is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world -- or even for a reasonable approximation to such objective rationality. Given these conditions, plus the actor's limited ability for dealing with all the information and alternatives available to him, the first principle . . . is that the intended rationality of the actor requires him to construct a simplified model of the real situation in order to deal with it. He behaves rationally with respect to this model, and such behavior is not even approximately optimal with respect to the real world [Simon 1959 in Pred 1967:26].

The complicated nature of our mathematical models and the relatively simple procedures which Jochim and Simon describe in real world decision making processes raise the question of whether people (or societies) optimize at all. In many cases people do not optimize; in fact, many aspects of human behavior are maladaptive. Witness the "sacred cows" of India (notwithstanding the attempts of cultural materialists to show how such customs are in fact, adaptive [Harris 1979]).

An alternative to a straight "caloric intake" optimization would take social relations into account. In some situations it is possible that the "optimization" of social relations inhibits or prevents the optimization of other resources. We cannot understand optimal foraging theory without understanding its relationship to "optimal socializing theory" -- (wo)man does not live by calories alone.

MODELS APPLIED TO THE SOUTHEASTERN LATE ARCHAIC

In this section I will examine two specific predictive models of Late Archaic settlement in the Southeast, the "Inter-Riverine Piedmont" model (House and Ballenger 1976; Goodyear, House and Ackerly 1979), and the "Riverine" model (Taylor and Smith 1978). Each of these has borrowed from one or more of the general models discussed above. Various predictions have been made about the nature and location of Late Archaic sites. Their creation reflects different attempts to operationalize higher level models such as optimal foraging approaches, or Caldwell's and Cleland's subsistence models.

The Inter-Riverine Piedmont Model

Traditional interpretations of Late Archaic settlement in the Savannah River region limited themselves to examining riverine patterns (e.g. Bullen and Greene 1970; Claflin 1931). Specifically, sites were predicted to have been situated along the floodplains of the Savannah River and its major tributaries (Anderson and Hanson 1988). Subsistence was geared to the exploitation of anadromous fish and various mussels.

This view predominated because of the archaeological research conducted in the area prior to the advent of major cultural resource management activities in the Georgia-South Carolina region in the 1970's. Most work was done in the major river bottoms (Bullen and Greene 1970; Claflin 1931; Dye 1976; Fairbanks 1942; Stoltman 1972, 1974; Waring 1968). No significant research had been done in the Inter-Riverine areas, so the hypothesized settlement pattern was confined to those areas where major work had been done.

However, this view did not accommodate the presence of large amounts of deer bones and oak-hickory shells found in numerous sites in the Southeast (Savage 1987). For this reason, and because of cultural resource management contracts related to construction of the Interstate 77 corridor through the Inter-Riverine Piedmont, House and Ballenger (1976) began looking for Late Archaic sites where no prior search had been conducted.

Three lines of evidence were put together to postulate the presence of Late Archaic peoples in the upland ravines: deer and nut remains in large quantities from excavated sites in the river bottoms, knowledge of white-tailed deer and forest ecology, and the Binfords' separation of archaeological activities into maintenance and extractive loci.

Data collected during the Interstate 77 project confirmed hypotheses related to an upland exploitation model, so House and Ballenger proposed the following settlement pattern for the Late Archaic in the upland ravine ecosystem:

> Based on the present data we propose a settlement pattern model for the Middle and Late Archaic involving spring and summer residence along major rivers; a move to seasonal base camps in upland creek valleys in September to take advantage of deer concentration in the upland hardwood zones, with some exploitation of other resources as well; and then a return to riverine-located winter quarters with permanent houses in about December when the coldest weather arrived, the deer rutting season came to an end, and the acorn mast in the hardwood forest began to be exhausted [1976:117].

Goodyear, House and Ackerly (1979) generally agree with this settlement hypothesis, but point out that the chipped stone tool types found in upland situations are not well correlated with nut processing activities:

> . . . it is difficult to see how the widespread and abundant low density lithic scatters so typical of the upland land surfaces would be directly related to nut gathering and processing. This is not to say that nut foods were not readily exploited in the Piedmont uplands, but that the evidence for this behavior is not likely to be found in chipped stone remains. The actual processing of raw nuts into storable foodstuffs for consumption of meats or for the extraction of commodities such as hickory oil might be better recognized through the recovery of storage pits (cf. Caldwell 1958:25-26) and perhaps ceramic vessels used for oil rendering. Such processing activities would not be expected to be present everywhere but likely at strategically located base camps with fairly protracted occupations.
>
> The strongest argument for the function of the numerous chipped stone scatter sites in the uplands lies with the hypothesis of deer hunting and perhaps the taking of other smaller game [1979:151].

Thus, while endorsing an overall interpretation of upland resource utilization in the Late Archaic, these authors caution that the extant archaeological evidence points toward an exploitative regime centered more on hunting than gathering. But, because of the archaeologically invisible nature of much of the equipment associated with nut harvesting (baskets, net bags, etc.), we should not rule out gathering activities, especially when we consider the abundance of nut remains in Late Archaic hearths.

Another important point related to the Inter-Riverine Piedmont model in the Late Archaic revolves around the issue of reoccupation of upland sites. Goodyear, House and Ackerly (1979) have addressed this issue by comparing the number of Late Archaic occupations from "pure", single component sites, with multi-component manifestations. The number of "pure" Late Archaic occupation sites was compared with the number of sites where the Late Archaic component occurred on a site exhibiting the previous Middle Archaic (Guilford) occupation. Speaking of the frequencies of sites in the Laurens-Anderson highway corridor survey, Goodyear, House and Ackerly write, "In cases where there were fewer sites in one period than the previous one, such as the Savannah River period, we would expect that all or 100% should be located on the previous Guilford period sites if no locational change had occurred" (1979:176). Whereas nearly a one hundred percent overlap between Guilford sites and the Late Archaic, Savannah River sites was expected, in fact the overlap was in the neighborhood of forty percent. They also compared the number of components found in upland and riverine ecozones. These results suggest that there was, in fact, a decline in upland utilization during the Late Archaic.

> This analysis indicated that during the period from about 3,000 to 800 B.C. [Late Archaic], major settlement changes took place that resulted in strong geographic shifts in site location from former settlement patterns. During this time interval (Savannah River through Otarre), a comparatively small number of sites occur in the Inter-Riverine zone, a pattern that suggests in itself that some change in settlement type may have been taking place [1979:177-178].

The overall effect of House and Ballenger's and Goodyear, House and Ackerly's work can, therefore, be seen as taking two steps forward, and one step back in its contribution to our understanding of Late Archaic settlement in the Savannah River region. The earlier work emphasizes the importance of upland extractive sites in the Late Archaic economy, but the later project cautions that this pattern was not as extensively utilized as in the previous periods, while pointing to the significant shift to river bottom settlement strategies. We are left with a sort of compromise between the earlier single-minded interpretation based solely on riverine site excavation, and that of House and Ballenger, based primarily on surveys in the upland ecozones, or we are forced to consider social factors which may be conditioning site placement and settlement pattern.

The Riverine Model

The importance of the riverine adaptation was thereby reaffirmed even while creating an inter-riverine model. Taylor and Smith (1978), in discussing the survey results from the Richard B. Russell Reservoir survey project, re-emphasized the connection between their work and the earlier river bottom projects. Their results are in line with those of Chapman (1973, 1978), who found numerous Archaic period sites in deeply buried floodplain contexts. Since the Russell Reservoir project was limited to surface survey, and limited testing of sites located in the survey, the fact that Late Archaic sites may be buried along the Savannah River only strengthens the Riverine model. Taylor and Smith have suggested that the Late Archaic was a river-extensive adaptation:

> The distribution of Late Archaic sites from the coast of South Carolina and Georgia up the Savannah River and into the Appalachian Summit area suggests that it was at this time that human adaptations were river system extensive. This is to say that, during the annual round, there were seasonal occupations of the various physiographic zones, i.e., the Coastal Plain, Piedmont and the Appalachian Summit [1978:323].

A river system extensive seasonal round, with travel between the coast and the Appalachian Summit, would involve the movement of large numbers of people over distances of some hundreds of miles. Moreover, the restricted distribution of Stalling's Island ceramics (penetrating as far up the Savannah River as the Stalling's Island site, south of present Augusta, but not into the Russell Reservoir area) suggests a cultural discontinuity. While it may be true, as Stoltman (1974) has suggested, that the Stalling's Island assemblage represents a seasonal manifestation geared to shellfish exploitation, separate groups may have practiced different riverine adaptations (depending on the local availability of riverine mollusks).

If such a discontinuity existed, people probably did not migrate up and down the entire length of the Savannah River during the seasonal round. Anderson and Hanson (1988) have suggested that this kind of migration occurred during the Early Archaic, when there were presumably fewer people and, therefore, more space in which to move around, but such movement would probably not have been practical for larger Late Archaic populations. A more intensive, year-round occupation of the Piedmont would allow seasonal movement within the various drainage basins such as the Tugaloo, Keowee, or Saluda (Goodyear, House and Ackerly 1979; White 1982). Such an occupation would allow for the full range of site diversity thus far discovered in the Savannah River Valley and its adjacent uplands, and at the same time conform to the general optimal foraging model proposed by Keene (taking into account differences between the Michigan and Georgia/South Carolina ecosystems).

The two specific models of Late Archaic land use that I have examined may be seen as applications of general models such as Caldwell's Primary Forest Efficiency, Cleland's Focal/Diffuse Model, the Maintenance/Extraction model developed by Binford and Binford and, to a large degree, optimal foraging strategies. The major point of contention has been the relative importance of upland ecozones to Late Archaic peoples. Issues related to social organization, to the changing cultural environment, and to technological changes in the Late Archaic have generally not been factored into these models.

REVISIONIST MODELS

As I have noted above, many of the researchers (Jochim 1983; Keene 1983; Moore 1983) who created models based on traditional approaches have cautioned us in their application. Significant questions related to social issues are not discussed in optimal foraging theory, but if we wish to gain a fuller understanding of the Late Archaic these questions must be faced. It was for these reasons that more recent "revisionist" models have been developed. These include models which consider the role of political economy as well as subsistence (Green and Sassaman 1983; Sassaman 1983) and operationalize information exchange in the creation and maintenance of social relationships (Moore 1983; Root 1983), as well as models of prehistoric social organization (Clark 1975; Wobst 1974), and models of boundary formation/maintenance (Marquardt and Crumley 1987; Green and Perlman 1985; Perlman 1985).

The Adaptive Flexibility Model

Green and Sassaman (1983) and Sassaman (1983) have postulated a model that considers the political economy of the groups involved, especially addressing the role of information exchange and mobilization of the means of production. Specific elements of the "Adaptive Flexibility" model are summarized by Sassaman as follows:

> Late Archaic adaptation to the Piedmont consisted of planned seasonal adjustments in resource selection, technological organization, mobility strategy, and social organization . . .
>
> Piedmont adaptation during certain seasons consisted of generalized subsistence, high logistical and low residential mobility, specialized, curated technology in conjunction with the use of expedient tools, and dispersed, formalized social integration as the primary means of resource management . . .
>
> Piedmont adaptation at times when aquatic resources were most productive consisted of specialized subsistence, high logistical mobility, sedentary residential camps, specialized curated technology, and social aggregation as the primary means of resource management [1983:155].

The reference to "planned seasonal adjustments in resource selection" recalls Caldwell's primary forest efficiency, and the model is still oriented primarily towards what people eat and where they get it. A pattern of seasonal movements is described; different resources are exploited during different times of the yearly round. Generalized subsistence is best thought of in terms of exploiting a number of resources in differing ecological niches at the same time, i.e., a "diffuse" adaptation. The specialized reliance on aquatic resources conforms to the "focal" end of Cleland's spectrum.

What is new in the adaptive flexibility model is the role of information managers, who appropriate surplus production, maintain communication during the diffuse part of the cycle, organize moves into diverse ecozones, and promote ritual as a means of maintaining their positions (Green and Sassaman 1983; Moore 1983; Root 1983). Unlike the other models I have examined, Adaptive Flexibility addresses issues related to the social organization of Late Archaic peoples.

I have noted above that the Late Archaic may not have been as egalitarian as we once thought hunter/gatherer groups were (Lee 1968, 1979; Bender 1985b). This model presents an explanation of emerging social differentiation among Late Archaic peoples:

> Seasonal aggregation was used to plan settlement moves and subsistence activities for the following seasons of settlement dispersal. With sound knowledge of resource availability and settlement relocation, residential mobility remained the cheapest solution to meeting the spatial and temporal schedules of resource procurement . . . .
>
> To control all the information necessary to make seasonal aggregation profitable, simple egalitarianism was replaced by some form of status differentiation. To reinforce information flow and control at the regional level, greater demands were placed on production. Accordingly, resources produced beyond the subsistence needs of domestic units served as currency for transactions involved with resource/information management and the maintenance of alliance systems. Ritual behavior at aggregation sites facilitated these sorts of transactions while diluting inequalities between interactive groups (cf. Root 1983) [Green and Sassaman 1983:278].

Ritual was probably practiced at aggregation times and places, specifically in the riverine ecozones during late winter and early spring, when the shad swim up the river systems of the Southeast in large quantities. Some were probably related to maintenance of the information network, and the legitimization of the information managers. Others, though, would have revolved around maintenance of a mating network. The extent of such a network is dependent on the social organization of the people involved in it. Several researchers have turned their attention to the study of this phenomenon.

<u>Models of Social Grouping</u>

Three primary models need to be considered at this point: 1) Dennell's (1983) Subsistence and Reproductive Group model; 2) Wobst's (1974) study of Minimal/Maximal Bands; and 3) Clark's (1975) model of Social Territories.

Subsistence/Reproductive Groups

Dennell has noted that two demographic groups need to be considered in hunter/gatherer societies: the subsistence group and the reproductive group (Dennell 1983). The nature and activities of the subsistence group are defined as follows:

> [The subsistence group] can be defined as a group of people habitually associated with each other throughout at least part of the year for the procurement of those resources necessary for their physiological well-being, and for the rearing of

> young and caring for the old and sick. . . . The size of subsistence groups does not have to remain constant throughout the year, but may change as members form smaller sub-units; for example, a hunting band might split into smaller groups at some times of the year to exploit dispersed resources. . . Nor does its membership have to remain constant, since members may leave to join another group and be replaced by others. However, at any given time of the year, its size should remain roughly the same from year to year. A subsistence group should also be associated with an annual territory: that is to say, with an area that it and its neighbouring groups will recognize as containing its food resources [Dennell 1983:12].

Dennell presents six different types of subsistence group land use patterns, two of which, the forager pattern and the logistic pattern, apply to hunter/gatherer groups. Foraging groups, such as the !Kung San (Lee 1979), display a pattern involving location at several base camp locations in a given year. A group will stay in one location until the resources are exhausted in that area. Daily food collecting, or foraging trips, will be made from the base camp. There is little storage of food.

In contrast, logistic collection involves splitting the subsistence group into smaller resource collection groups, whose task is to move to a location different than the base camp and there collect or extract specific resources at specific times of the year. When a sufficient amount has been collected, the workers return to the base camp. This strategy involves, therefore, a planned seasonal dispersion, collection of specified resources, a central base camp, and logistical camps occupied by the collecting groups while they are away from the central camp. The use of such a system involves considerably more organization and planning, with its attendant opportunities for information management and task direction. Most of the subsistence models developed in the Southeast involve this kind of resource procurement strategy (Taylor and Smith 1978; Sassaman 1983). Note, though, that in both examples, Dennell stresses that resource procurement takes place within a defined territory, understood by both the endogamous group and its neighbors.

The reproductive group in Dennell's model is the mating pool:

> As a demographic unit, the subsistence group is usually too small to provide its members with an adequate range of potential mates. For this reason, we need to recognize a larger unit which can be called the reproductive group. This comprises a set of subsistence groups within which the members of any one unit will tend to find a mating partner; it is, in effect, the regional breeding population that ensures the long term viability of each subsistence group. Since it functions both by encounters between and within groups, it also serves as an information network that can provide each subsistence group with knowledge about their neighbours and their regional -- as opposed to local -- environment [1983:14].

Subsistence groups were probably dispersed into the hinterland for much of the yearly round during the Late Archaic, while the reproductive group came together at floodplain agglomeration sites in late winter/early spring. Depending on the size of the agglomerative groupings, more than one reproductive group may be represented in an "information management group", or band.

The subsistence group, reproductive group, and information management group are but three examples whose inter-relationships are part of a dynamic political economy. Other age/gender groups may be envisioned (Conkey 1988). The "optimization" of these inter-relationships provides substantial opportunities for information managers to manipulate relations between and among groups for political advantage (Root 1983), and some of that manipulation can be seen in the spatial distribution of sites on the landscape with respect to each other and to environmental factors.

Minimum/Maximum Bands

Wobst's (1974) study of Paleolithic social systems also emphasized a two-tiered social system. In his system, minimum and maximum bands take approximately the same positions as Dennell's subsistence and reproductive groups. The Minimum Band is defined as:

> . . . the most permanent and strongly integrated unit in hunting and gathering society. Its size is large enough so that it will survive prolonged periods of isolation through the cultural practices of cooperation among its members, division of labor according to age and sex, and mutual food sharing. On the other hand, it is sufficiently small to not place an undue strain on the local food resources.
>
> Such minimum bands tend to consist of several families of consanguine and/or affinal relatives who, at least part of the year, share a common settlement and participate in a given range of cultural activities. The size of these units allows the unimpaired transmission of the cultural system from generation to generation [1974:152].

Wobst conducted a simulation study based on an average assumed minimum band size of twenty-five people, derived primarily from ethnographically observed hunter/gatherer groups. Other studies suggest, though, that minimum band populations may have ranged from fifteen to fifty (Hassan 1981). Perlman indicates that in the temperate Southeast, during the Late Archaic, minimum bands may have been considerably larger, perhaps between 100 and 300 people (based on one person per square kilometer) (Perlman 1985:42).

Leaving aside the issue of minimum band size for the moment, Wobst points out, as does Dennell, that the minimum band would not have contained enough people to maintain the reproductive viability of the group, thus a larger group is required.

> While at least potentially self-sufficient, a given minimum band tends to participate in a larger social network in order to enhance its chance of biological and cultural survival. Steward (1969:290) defines this larger social network (the maximum band) as "frequently . . . little more than a group with which its members somewhat vaguely identify." It essentially constitutes a marriage network which guarantees the biological survival of its members, since the members of a minimum band have to rely on a larger number of persons than their own membership in order to provide a member with a mate upon reaching maturity.
>
> Mate recruitment is made possible by, and itself stimulates, integrative processes between the different minimum bands of the social network. The integrative processes, in turn, enhance the chance of survival of the minimum bands and their members. Thus, food sharing and visiting between adjacent bands create an atmosphere conducive to the exchange of mates. At the same time, and at least as importantly, they help to counteract variations in the food supply at the local level and dynamically adjust the local population size to a level which can be supported by the resources at a given time. Barter meetings and work parties between members of different bands broadcast the availability of mates within the communication network of the maximum band. At the same time, the former process provides a given band with exotic raw materials, while the latter increases the exploitative efficiency of local groups [Wobst 1974:152].

Thus it is the larger, maximum band, that provides the "glue" that holds hunter/gatherer society together, by providing a larger mating pool, by informal exchange of raw materials, by cooperative resource extraction, and by mitigating the effects of micro-environmental perturbations. The maximum band size is related, according to Wobst, to the various rules governing the selection of mates. A completely open system, with no incest taboos, for example, would require about 175 people to insure reproductive viability. The more restricted the mate selection rules become, the more people are required to operate the mating network, and hence, the maximum band size increases. Hassan (1981) estimates a required size range of between 200 and 500 people.

Like Dennell, Wobst assumes a territorial organization for the minimum bands:

> The movement of entire maximum bands, or their components, beyond the area which their cultural system permitted them to exploit, and with which they were familiar is . . . effectively blocked by social boundaries. A given society was not located in a vacuum but in a social environment, that is, in a network of neighboring maximal bands.
>
> The territoriality of hunters and gatherers is determined at the organizational level of the minimum band. The "territory" of these groups is usually not maintained through an exclusive claim but through habitual use. It is delineated by the proximity of other minimum bands, by distance, by familiarity with the environment, and by natural obstacles [Wobst 1974:153].

These territories, within which minimum bands operate, and defined by other minimum bands, distance, and the physical landscape, are what I choose to call, after Wobst, "Habitual Use Areas", since they are maintained not through claim but by use. One of the aims of this thesis is to delineate such "habitual use areas" within the Richard B. Russell project area.

Social Territories

Both Dennell and Wobst assume some sort of territoriality associated with subsistence, or minimum bands (that which I call habitual use areas). Clark (1975) assumes four levels of social territories. Two of these, the annual and the social territory, are roughly analogous to the territories exploited by, on the one hand, subsistence or minimum bands, and on the other, by reproductive or maximum bands.

> In the case of most societies that depend wholly or in any substantial part on catching and gathering, it is necessary to move the home base in order to exploit seasonal opportunities [this appears as a combination of foraging and logistic strategies]. The home base may and generally does remain at one or more locations for periods measured in months during periods of cold or heavy rainfall as the case may be, but at other times of the year it may shift rather often and assume a rather periodic character. In this case it is useful to adopt the term annual territory to designate the total territory exploited by a group in the course of a year. . . .
>
> By social territory I mean the total territory drawn upon for supplies, including raw materials and finished products as well as food-stuffs, by a given community by virtue of belonging to a larger social grouping [Clark 1975:13-14].

On the lower end of Clark's territorial scale is the Home Base, which is in some ways analogous to the base camp of a minimum band. The home base is that area, including the base camp, and a region surrounding it (which he defines as a one to two hour walk in radius, after Higgs (1971)) from which plant and animal resources are drawn. This concept effectively blocks a logistic economy, since with logistic collection a camp is set up near the exploited area, supplies are accumulated, the camp is broken, and the people and supplies move back to the base camp.

At the larger end of Clark's scale is the Technological Territory, delineated by common tool types, flaking methods, and the like. An example can be drawn from the entire Southeastern United States during the Late Archaic, when the region shared a common lithic technology and produced a common tool type, the Savannah River point.

It seems, then, that we can think of the Late Archaic in terms of social territories occupied by distinct minimum bands, organized at a higher, though looser, level into maximum bands. Such groups are believed to have occupied distinct physical territories on the basis of habitual use, especially at the minimum band level. The hypothesis that will be advanced in a later chapter is developed from this notion of social territory and social grouping.

<u>Models of Frontiers and Boundaries</u>

Once we begin to think in terms of social groups in habitual use areas, or territories, then questions of group boundaries arise. Marquardt and Crumley address the notions of the boundary asan edge, that is, as a division between two areas or groups, and that of the boundary as a center, where different activities, some related to boundary maintenance, and others related to exchange, cooperation, communication, or the like take place.

> For us the dual nature of boundaries is of primary concern. Boundaries are dual in that they are artificial divisions of the physical landscape; by virtue of their continuity, they effect discontinuity. But beyond this conception of boundary as barrier or as dividing line, boundaries themselves are worthy of study because they often serve simultaneously as <u>edges</u> and <u>centers</u> within the landscape under investigation. For example, the quantity of information and/or goods moving <u>along</u> a boundary may often be significantly greater than the quantity moving <u>across</u> that boundary. From the standpoint of the groups divided by the boundary, that boundary is an edge, a periphery. From the point of view of participants in commerce and communication, the boundary is in fact an important kind of functional center [Marquardt and Crumley 1987:8].

The concept of the boundary as a center becomes powerful for the Late Archaic when coupled with Wobst's notions of interaction between minimum bands. As I have noted above, Wobst pictures a number of integrative processes, including mate selection, exchange, sharing of extractive tasks and mitigating environmental fluctuations, that occur between minimum bands. Though these bands are defined as residing in territories, there is a significant amount of interaction across the boundaries of the various habitual use areas. For those engaged in such interaction, the boundary thus becomes a center.

Green and Perlman (1985) have noted the importance of studying boundaries as part of open-system research:

> Frontier and boundary studies recognize that societies are open. By so doing, they can contribute insights into the processes that produce the spatial, temporal, and organizational variability observed in the archaeological record. First, they open prehistoric and historic archaeology to a systematic study of noncentral places and the links between these and the traditionally studied central place sites . . . .
>
> Second, broad historical patterns have taught us that social change often is most visible, and in some cases most active, on the peripheries of social systems . . . .
>
> Finally, frontier studies are a natural and perhaps necessary element for the study of long distance spatial process [Green and Perlman 1985:9-11].

Once we begin to think of the Late Archaic in terms of a social system delineated by minimum and maximum bands, occupying habitual use areas, then we open the archaeological record to the study of both the areas themselves, and the boundaries between them. By recognizing that the boundary can serve both as an edge and a center, we can begin to consider those processes that run along the boundary, and those that cut across it, and begin to ask questions related to their functions in the past cultural system.

APPLYING GEOGRAPHIC LOCATION THEORY TO THE LATE ARCHAIC

Summarizing the results of twelve years of cultural resource management projects in the Russell Reservoir, Anderson and Joseph (1988) point out a dichotomy between the early, pre-ceramic phase of the Late Archaic and its later, Stalling's Island (ceramic) phase:

> Only minimal evidence for interaction with populations in the coastal plain, ridge and valley, or Appalachian Summit was documented in the three primary [excavated] pre-ceramic Late Archaic occupations examined in the reservoir. This pattern appears to change in the subsequent, ceramic Late Archaic, with the appearance of Stalling's pottery and a greater range of raw materials within projectile point assemblages . . .
>
> The evidence from the Russell Reservoir suggests that preceramic Late Archaic adaptations were complex, and the trend toward extended, sedentary occupations suggested by massive shell midden sites such as Stalling's Island, had already begun . . . . The data from the Richard B. Russell reservoir, which document the presence of dense local Late Archaic populations, probably exploiting riverine resources (even if not shellfish), reduces the necessity to look elsewhere for the origins of this adaptation [1988:V-60].

In many ways this summary points out the stagnation of research in southeastern Late Archaic studies. After twelve years of extensive survey and excavation along the Savannah River Valley, and thirty years after Caldwell published his dissertation, we are still talking about "adaptation" and subsistence. The shell mounds we have known about for fifty years play an important part in a subsistence scheme, but what do they say about social organization? We already knew that the Late Archaic population levels were relatively dense, but what does that mean for interpersonal and inter-group relations?

These questions require a body of theory that encompasses both social and spatial relations. "There is always a whereness to meaning-making and experience, and to power -- a spatial frame" (Conkey 1988). It is not my purpose here to answer all of the questions that arise from a consideration of society, space, and interaction, but rather to place them within a body of theory and a methodology which will allow us to examine the spatial frame, and hence come to a better understanding of the questions -- and ultimately, to formulate answers.

If we are to use a geographic theory of site location it must address some of the fundamental problems associated with the traditional approaches, and incorporate revisionist ideas. In particular, it should address issues related to individual responses, the role of information as either a shared commodity or a "currency", and variations in either individual or group ability to utilize resources for individual or group ends.

"Such a body of theory would embellish existing location theory by taking into account nonoptimal behavior, imperfect knowledge, other psychological variables, socially dictated constraints, and the impact of existing patterns on subsequent patterns (processes)" (Pred

1967:16). We in archaeology have been slow to consider the fact that a geographically based theory is in line with our own goals, namely, an emerging emphasis on individuals in cultural and social relationships, and a contextual approach in archaeological research.

In order to understand spatial patterning of archaeological sites in this manner, it is necessary for us to realize that the archaeological record is a spatially distributed result of human decision-making activities, whether as individuals, or as groups of people. Since it is apparent that individuals and groups do not necessarily practice optimal foraging, the problem becomes one of organizing the contents of decision-based locations for purposes of analysis. Such locations may represent situations of "optimal socialization" rather than optimal foraging, or they may represent combinations of both. That is, there are other constraints operating on groups and individuals -- many of which are related not to subsistence but to social relationships. Social relationships, such as information management, or the maintenance of reproductive networks, to name two examples, form additional conditioning factors that affect subsistence <u>and</u> site location.

Pred (1967) has created a "behavioral matrix" that performs such an organization. The information available to decision makers, and their ability to act upon that information, are seen as axes of a two-dimensional grid of infinitely small gradations. "Every locational decision is viewed as occurring under conditions of varying information ability, ranging, at least theoretically, from null to perfect knowledge of all alternatives, and as being governed by the varying abilities (as well as objectives) of the decision makers" (1967:24).

Pred's matrix takes the form of information on the vertical axis, and the ability to use that information on the horizontal axis. What we have described as an "optimal solution" may be thought of as occupying the far upper-right position of the matrix -- it is dependent on perfect knowledge and perfect ability to exercise that knowledge.

Pred's Behavioral Matrix

```
I   |.............................................* (optimal solution)
n   |                                             .
f   |                                             .
o   |------+                                      .
r   |      |  An equal area under the matrix can be achieved
m   |      |  by maximizing information, at the expense of
a   |      |  action, or by maximizing action rather than
t   |      |  information.                        .
i   |------+---------+                            .
o   |      |         |                            .
n   |      |         |                            .
    +------+---------+-----------------------------
                   Ability to Act
```

Since no individual or group can be shown to optimize, it follows that each contextual particular must fall at some point below and to the left of the optimal solution point.

> Hence, in any given situation, each locational decision making unit or actor, be it a single person or a firm [or band, tribe, or chiefdom], can be thought of as jointly having a real spatial attribute (site and situation, land use or path of movement) that is reproducible on a map, and behavioral qualities that can be hypothetically located in the behavioral matrix [Pred 1967:24].

Such a construct has great power for interpreting site location when we consider, as Green and Sassaman (1983) have done, the role of political economy in the creation of settlement patterns. The use of information as a currency to maintain control over individuals or groups who do not have access to that information clearly impacts upon their position along the vertical axis of the locational matrix.

> Marshall (1959:337) notes . . . limitations on locational behavior: "!Kung of the Nyae-Nyae region almost never went outside their region because in strange places they cannot depend upon food reciprocity and either do not know where wild foods grow or might not be allowed to gather them". Note that food reciprocity and information sharing about the distribution of food resources are implied to be coterminous, and that withholding information about the distribution of resources can be an effective mechanism for controlling the use of resources [Moore 1981:202].

This can be especially important when we think of the role differential knowledge can play in foraging societies, in terms of the effectiveness of an individual's or a group's foraging activities. I have noted above that the presence of age and gender differentiated grave goods at Indian Knoll and Eva, and the existence of long-distance trade, imply that the Late Archaic is not as egalitarian as we once thought. The presence of emerging elites in an incipient ranked society should be considered, and their role in society explored. Restricting knowledge about resource "hot spots" could have meant selecting for non-survival, and hence could have been a powerful coercive tool in the hands of incipient elites. Furthermore, since dispersed populations require a greater expenditure of effort to maintain communication and share intelligence, it becomes easy to see how an emerging elite might capitalize on this difficulty by encouraging dispersal during some times of the seasonal round (cf. Sassaman 1983 and Root 1983).

The information managed in this manner may be either environmental or social. Environmental information is coded <u>into</u> the environment, and includes such factors as the location of good quality raw material sources, or the distance to water sources. In short, it is geographic information. Social information is coded <u>into</u> people, through ritual and tradition, and <u>onto</u> the environment. An example would be the location of a site with respect to its nearest neighbors, or the centrality of a site with respect to both its environment and its function in a social setting. By examining such social and environmental factors through the geographic location matrix we can come to a clearer understanding of the operation of the Late Archaic socio/political economy.

Equally exciting possibilities accrue when we interpret the horizontal, "ability to act" axis of the locational matrix. If an emerging elite is skimming off the surplus production in a society in order to maintain power, there may have been times when the ability of others to exploit a given situation was hampered by obligations to the incipient elites. In addition, since part of the role of information and its managers may have been to promote alliances, the ability to act on a given piece of information may well have been influenced by the nature of an agreement made between regional elites.

Another example of the "ability to act" matrix may be seen in the location of particular site types with respect to their surroundings, as a means of interacting with the information axis. Since environmental information is coded into sites, we would expect it to vary depending on the function of a particular site. For example, in hunting camps much of the information coding may have to do with the view of the surrounding territory, thus affording a better view of game. Such sites may compensate for an increased difficulty in actually capturing the prey. That is, the information axis is manipulated in order to compensate for a relatively low position on the "ability to act" axis.

With the application of a locational matrix of this sort, it becomes possible to interpret the Late Archaic settlement pattern in the Savannah River Valley as a series of locational decisions whose efficiency was directly influenced by the "management" of an emerging elite class. We are able to consider the roles of individual actors and groups of actors. Such a view is in agreement with Hodder's notion of the individual in society. People are active participants in creating and transforming the rules and expectations of the society within which they live; culture is "meaningfully constituted" (1986).

The use of the geographic location model in archaeology is best conducted within a contextual approach to the archaeological record. When we view the archaeological record as the spatial and material correlates of human decision-making activity within an active political economy, we are able to see the results of that decision-making by looking for pattern within the archaeological record.

LANDSCAPE ARCHAEOLOGY

The study of archaeological landscapes involves both the physical environment and the cultural environment. People live in a world that is partly a product of their natural surroundings, partly a product of their inherited cultural surroundings (subject to individual interpretations), and partly a product of their own actions. If "All the world's a stage", then the actors on that stage are engaged in not only the action of the drama of life, but also engaged as set builders and playwrights, for each individual constructs a personal interpretation of their physical and cultural landscape:

> Societies form and are formed by their natural and constructed environments. . . . how a group adjusts to a geographic area reflects much of the group's history, organization, and values, and in turn such adjustments influence that group's perception of the physical and the constructed environment. The landscape is the spatial manifestation of the relations between humans and their environment [Marquardt and Crumley 1987:1].
>
> Landscapes, which may be defined as the assemblages of real-world features -- natural, semi-natural and wholly artificial -- give character and diversity to the earth's surface and form the physical framework within which human societies exist. They are closely linked to all aspects of human life, for not only are there practical economic bonds -- the majority of human beings that ever lived were hunter-gatherers or peasant farmers -- there are also powerful social, religious and psychological bonds [Roberts 1987:79].

The concept of Landscape Archaeology has the power to unite many of the themes discussed in this chapter. Geographic Location Theory must be considered a part of landscape studies, since it considers site location in terms of information and action, and recognizes the contradiction between the two, and between the perceptions of the cultural landscape "shared" by members of a society.

Models of social organization, such as Dennell's subsistence/reproductive groups, or Wobst's minimum/maximum bands, can be studied under the rubric of Landscape Archaeology (as will be done in a later chapter). These social groups lived on a physical landscape, and in a cognized landscape. The remains they left behind can inform us about the nature of that landscape.

Since social organizational models are played out on the physical, as well as the cultural, landscape, the study of frontiers and boundaries must be considered to be an important part of Landscape Archaeology. Understanding the way people interacted across and along such boundaries can, as Green and Perlman (1985) have pointed out, provide us with valuable insights into the nature of the spatial and temporal processes that affect open social systems.

Similarly, models of Maintenance/Extraction, models of differing modes of subsistence, and models of different collecting strategies can (and must) be studied under the general umbrella of Landscape Archaeology. Each activity associated with such models produces patterned remains in the archaeological record that can, if studied as part of the physical and cultural landscape, tell us much about the way prehistoric peoples used their world. "In all these instances, spatial structure is both the medium and the outcome of social practices. It is neither ideology nor social reality but it integrates both in the moments of daily life" (Hodder 1987:143).

SUMMARY AND CONCLUSIONS

I have examined various levels of settlement models used to interpret the Late Archaic, ranging from Caldwell's "primary forest efficiency", through optimal foraging models, and finally to specific models, or explanations, of settlement in the Savannah River Valley. These three types of models are inter-connected: primary forest efficiency has been brought closer to the ground through the use of optimal foraging theory, by asking questions about how primary forest efficiency operates in the real world. Optimal foraging theory, in turn, has been made specific within the Savannah River Valley by the formulation of settlement models that make use of its assumptions and conclusions.

Most of the differences between the specific settlement and subsistence models that have been proposed are related to the relative importance of the upland ravine ecozone to Late Archaic hunter/gatherers. Various models have focused on a predominantly riverine economy, on a heavily upland orientation, or some sort of mixture of the two. With the exception of the Adaptive Flexibility model no real attempt has been made to integrate political economy into the settlement scheme.

Optimal foraging theory has been a mixed blessing. On the one hand it has provided for an in-depth inquiry into the modes of production surrounding Late Archaic subsistence, and has contributed greatly to our understanding of the parameters of an ideal solution. On the other hand, it has been shown that the theory ignores the relations of production (the political economy), presents an impossible goal (optimization), and is based on questionable borrowing of models from the biological sciences. It is at once too simple and too complex in its approach to how the world works versus how people model reality. As such, its utility for operationalizing Late Archaic settlement studies must be questioned.

Landscape Archaeology, when coupled with Geographic Location Theory and the methods of Geographic Information Systems, can provide powerful insights into the way in which past societies found, transformed, and passed on their physical and cultural surroundings.

When used as an overarching theoretical approach, Landscape Archaeology can be shown to unite many of the issues and phenomena currently studied under different paradigms. Social organization, the origins of conflict and conflict resolution, subsistence models, locational models, and information models can all be studied as phenomena that result in patterning on the social and physical landscape.

The next chapter will discuss Geographic Information Systems and their use in archaeological research, in preparation for an analysis of the Late Archaic sites in the Richard B. Russell Reservoir under the rubric of Landscape Archaeology, and using GIS methods.

CHAPTER III

GEOGRAPHIC INFORMATION SYSTEMS IN ARCHAEOLOGICAL RESEARCH

INTRODUCTION

The development of Geographic Information Systems has been a recent phenomenon, and its use in archaeological research is more recent still -- limited, in fact, to the last five-or six years. Even among geographers the definition of a true GIS is still a matter of debate (Berry 1987, Clarke 1986, Cowen 1988), so it is not surprising that some confusion exists among archaeologists as to exactly what a GIS is, and what it can be used for in archaeology.

Although most archaeologists are still unfamiliar with the subject, several researchers have begun to explore different archaeological problems with GIS methods. The list of titles is still short, but three main lines of research appear to be emerging: 1) site location models developed primarily for cultural resource management purposes; 2) GIS procedure related studies; and 3) studies that address larger theoretical concerns related to Landscape Archaeology through GIS methods. In this chapter I will review these uses of GIS in archaeology. I would like to place particular emphasis on the third line of research (even though most papers written to date deal with the first), since I feel that GIS can greatly facilitate the study of general questions related to the settlement, environment, and sociology of archaeologically studied populations.

Since there is still some debate about what constitutes a GIS, I will first offer a basic definition of these systems, and briefly describe the two major types of GIS available, especially touching on points that are pertinent to the use of GIS in archaeology.

GIS DEFINITIONS

A basic understanding of what a geographic information system is can be gained by first understanding what it is not, or rather, what it is more than, in terms of other computer-based mapping software available. Cowen (1988) has noted that, "The basic premise is that a true GIS can be distinguished from other systems through its capacity to conduct spatial searches and overlays that actually generate new information." By placing the emphasis on the creation of new information, Cowen thus differentiates between GIS and CAD (computer aided design or drafting), and between GIS and DBMS (data base management systems). Software systems which automatically draw maps or assign symbols to maps cannot be considered to be true GIS, since they are not creating new information. These systems are essentially only computer driven drafting programs.

Computer mapping programs (CAM) such as GIMMS are also not GIS. The basic difference between CAM and CAD systems is that CAM systems provide a sort of rudimentary linkage between a computer drafting program and a database management system. Cowen notes, though, that, "While linking a database to the pictorial representation of geographical entities enables the researcher to address an extensive array of geographical questions, a computer mapping system is still not a GIS" (1988:1552). "The term [GIS] is restricted to those computer systems which have the capability to interrelate data sets pertaining to different variables and/or to different moments in time. Thus, facilities solely for the manipulation or mapping of individual files are not here considered as geographic information systems" (Rhind 1981:17). "GIS are NOT simple graphics/mapping systems, but are systems that interrelate, manipulate, and analyze a variety of geographically distributed data in addition to mapping" (Kvamme 1987:2).

GIS systems are, therefore, those which provide for the storage, management, retrieval, display, and creation of geographically referenced data. Crain and MacDonald (1983) have noted that GIS systems typically evolve from inventory systems to analysis systems to decision support systems. Cowen (1988:1554) emphasizes that, "a GIS is best defined as a decision support system involving the integration of spatially referenced data in a problem solving environment."

Data in a GIS are spatially referenced. Twenty-five years ago the geographer Brian Berry (1964) envisioned a geographic matrix containing columns which represent places, and rows which represent attributes or characteristics of those places. By looking at spatially referenced data in this way, we can imagine scanning across a series of locations while looking at the same characteristic, or looking at a number of characteristics applicable to the same place. By adding matrices we can begin to accumulate similar data sets for different times. The information stored in a GIS may, therefore, be thought of as bits of data related to Spaulding's space, form, and time. Archaeologists have traditionally had difficulty controlling all three of these dimensions simultaneously, but the use of GIS provides methods for doing so, and at the same time storing and manipulating vast amounts of spatially referenced environmental data such as elevation, vegetation, hydrology, and land use.

TYPES OF GIS

The two main types of GIS, vector and raster, handle the task of spatial referencing in different ways. Each has advantages and disadvantages for the archaeologist, and will be discussed below.

Vector Based Systems

Vector based GIS such as Arc/Info (ESRI 1986) use a topological structure consisting of points, lines, and areas, or polygons, to represent spatial phenomena. We usually perceive the real world as made up of such structures, and at least some of this perception is accurate. Geodetic survey stations are point data, roads are lines (this is actually more problematic than it appears, since roads have width as well as length, so at a larger scale they are areas), regions of homogenous soils are polygons.

Maps have been drawn with vector type data throughout history, and, in fact, have as their basis geometric relationships among points, lines, and polygons. The vector approach in GIS, therefore, has some attributes that make it more satisfying for the display of certain types of features. "Vectors work well when real world spatial conditions can accurately be defined as lines or edges. Examples might include property lines, the face of a building, or the center line of a pipeline" (Maffini 1987:1397). Vector based GIS also tend to produce map output that is more aesthetically pleasing; it looks like the kinds of maps we are used to. As archaeologists we think in terms of irregular boundaries around sites, features, soil types and the like, and lines are well represented in vector based GIS.

Drawbacks to the vector approach include slow processing times, difficulties in performing Boolean manipulations between different map layers, and generally, the higher cost of equipment used in these systems (Maffini 1987, Kvamme 1988). The process of encoding, or relating points to lines and polygons, polygons to other polygons and lines is complicated; depending on how it is done, it can produce "sliver polygons" and other errors in the data structure (Peucker and Chrisman 1975).

Perhaps for archaeologists, though, the most serious drawback in vector based systems stems from what at first looks like their most attractive feature, their ability to draw accurate lines on computer screens and maps. Maffini explains the problem in "Raster versus Vector Data Encoding and Handling" (1987:1397-1398):

> The vector approach has . . . been used in circumstances for which it is not ideally suited. When we look at an image of a region, we see many phenomena which have no sharp boundaries. When we impose lines (vectors) on the image to bound such phenomena, we introduce a highly precise interpretative element into the data which is misleading . . . Once the line has been drawn it takes on a certain immutability.
>
> An important consideration in determining the suitability of a particular data structure is related to the level of accuracy of the information being presented. A classic illustration of this issue is encountered when spot observations (point data) are interpolated to produce contour maps representing continua (e.g. precipitation, elevation of terrain).
>
> The contours (vectors) that define points of equivalent magnitude on a surface are usually calculated from a rectilinear grid or a random set of point observations. Isolines do not, of course, exist in the raw data, they are merely calculated by mathematical interpolation. Although such lines are drawn explicitly, the interpolation method itself may not support the accuracy that is implied by the use of lines [1987:1397].

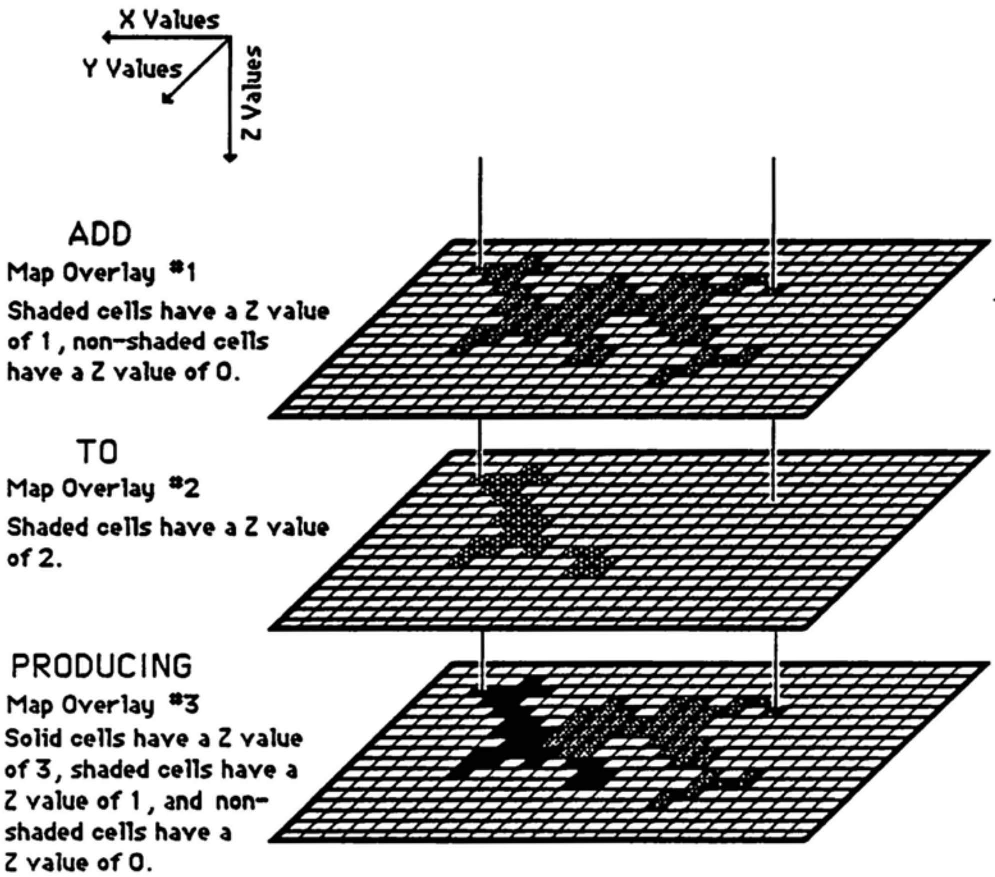
This problem is particularly applicable with archaeological survey work. Although sites may be shown to have boundaries, what do we mean by a site boundary? Is it the place where the surface scatter stops, and if it is, how is that scatter of point data (the artifact positions) recorded as a vector boundary? Usually a ring is drawn on a map, and becomes the site boundary, but it clearly is not drawn by connecting the points of artifact occurrence at the edge of the site. What if we define the site as the limits of human activity associated with a particular locus? Although we take as assumptions that human behavior is patterned, and that it produces patterned remains in the archaeological record, it is not necessarily so that all kinds of behavior produce artifactual remains. Under this definition of a site, we might actually never be able to define a boundary. The problem with the vector approach for archaeologists is, then, that it reifies a boundary whose definition is suspect.

Raster Based Systems

In raster based systems a region is represented by a matrix of grid cells (usually square) forming rows and columns on the X,Y axes, and a numeric Z value that represents some characteristic of the region such as topography, soil type, or slope. Values are assigned to the grid cells in a variety of different methods which are usually under user control. These include a binary switch (presence/absence), extreme value (highest or lowest), average value, predominant value, or centroid of cell (the value at the center of the grid cell is assigned to the entire cell). Numerous GIS have been developed using raster based data structures, including the Map Analysis Package (Tomlin n.d.), and its derivative which I have used for this project, MapCgi (Cowen and Rasche 1987).

The advantages of raster based systems include a simple data structure of X and Y locations, with Z values, which make these systems easier to understand and operate. The data structure is easy to manipulate mathematically, making analysis (especially Boolean operations) simple and rapid. For example, two map layers may be combined by simply adding the Z values from each separate layer, on a cell by cell basis, and assigning the sum to a new map layer (Figure 2). The maps may thus be manipulated algebraically. The raster approach is also excellent for handling continuous data, such as elevations, but at the same time can represent such discrete themes as soil types.

The Map Analysis Package operates on layers of geographic and thematic data mathematically, through a process called "Map Algebra".



The Z values on one or more map overlays can be manipulated mathematically to produce other map layers with new information. FOR EXAMPLE: A map layer of elevations can be differentiated to produce a layer of slope values or The Z values in neighboring cells in an elevation layer can be compared to produce an overlay of slope direction.

Figure 2. Geographic Information Systems' "Map Algebra".

In vector systems, if Boolean or algebraic operations are to be performed, there is often a hidden conversion of vector to raster data. The operation is performed, and the data is re-converted to vector for display (Maffini 1987). While there is only one possible result when data is converted from vector to raster, there are many when raster data is converted to vector, so additional problems of interpretation are introduced.

Disadvantages in the raster approach include the large file space required. Typically, a raster system stores arrays of two byte integers (numbers ranging from -32,767 to 32,767 that can be stored in the computer in two character spaces). Even a modest sized map overlay, for example, 100 rows by 100 columns, requires 20,000 bytes of storage, and this is repeated for each map theme in the system. The numeric arrays must be operated upon in computer memory, often two at a time, so hardware memory (and display) limitations do not allow very large matrices. The MapCgi system, for example, does not allow more than 64,000 grid cells in the database. In operational terms, this means that large areas must be handled at small scales, so detail is lost. As an example, the state of South Carolina is available in the MapCgi system, but the grid cell size is one kilometer. There is a considerable loss of detail as a result. Increasing the resolution automatically decreases the area that can be examined in a grid cell system, so a compromise must be created between region and scale, which the user of the system is called upon to make, sometimes before enough information is present to make an informed decision.

Despite these limitations, Kvamme notes that raster based GIS

> . . . are particularly well suited for analysis and modeling applications not only because virtually any type of data can be encoded and stored cell-wise, but because these data can be accessed for univariate or multivariate analyses and complex algorithms or decision models can be applied to them. For this reason cell-based GIS have predominately been used by archaeologists for modeling and research purposes [1989:15].

ARCHAEOLOGICAL APPLICATIONS OF GIS

In this section of the chapter I will examine some of the modeling and research purposes that archaeologists are addressing with GIS methods. As I noted above, there are three main areas of research currently conducted via GIS: 1) site location models developed primarily for cultural resource management purposes; 2) GIS procedure related studies; and 3) studies that address larger theoretical concerns related to Landscape Archaeology through GIS methods. Each of these research trends will be discussed below.

Site Location Models and Cultural Resource Management

Kvamme (1989:28) notes that the use of GIS for "predictive archaeological location modeling, with its vast data, computational, and cartographic needs, has thus far been the predominant application of GIS in archaeology." This use of GIS as a cultural resource management tool may be seen to stem directly from Clarke's (1986) emphasis on the development of GIS as a management tool, and Cowen's (1988) definition of GIS as "a decision support system involving the integration of spatially referenced data in a problem solving environment." The goal of this approach is to locate areas that are sensitive to the presence of archaeological sites in advance of development, and plan the development phase of a terrain altering project so that it avoids the sensitive archaeological areas. In development projects, "as in other multipurpose planning, the objective should be to maximize all potential complimentary social benefits at the least social costs" (McHarg 1971). By presenting archaeological compliance work as a social cost which can be avoided, the actual expenses of archaeological mitigation are reduced, and fewer sites are likely to be destroyed. This method offers results that benefit both archaeologists and developers.

Several studies of this nature have been conducted, some with vector based systems, and others with grid cell or raster systems. The basic approach involves creating a mathematical model and then applying it to the region in question.

> A popular methodology by which archaeologists can develop empirical predictions is through quantitative site location studies. To many archaeologists, these site location studies are based upon the assumption that non-cultural aspects (independent variables) of the environment will correlate with and predict site locations (Ebert, Larralde, and Wandsnider 1984). Although many archaeologists equate quantitative site location studies with predictive modeling, they will be regarded here as empirical observations which inductively project site location (Ebert and Kohler 1986:4). In other words, they are simply correlational models [Marozas and Zack 1987:1].

One approach to the creation of site location models involves using logistical regression techniques in a statistical analysis package such as SAS (SAS Institute 1985). This technique allows a binary, presence/absence indicator of an archaeological site to be used as the dependent variable, and various other environmental factors such as elevation, slope, distance to water, and the like, as independent variables (Marozas and Zack 1987, Warren et al. 1987). It is particularly important to understand the relationship of site locations to these independent variables <u>versus</u> non-site locations. "The central points [site locations] must exhibit a different set of associations if one is to distinguish between background and potential sites" (Marozas and Zack 1987:2-2). This emphasis on non-site locations should not be confused with non-site archaeology as defined by Thomas (1975:62), in which the individual artifact is the point of reference, and traditional sites are ignored. Rather, these non-sites are places that are not archaeological sites (that is, where no human cultural remains or activity exists) where environmental data may be collected (Kvamme 1982:4).

A problem with this approach is that, in the absence of explicitly collected information about where sites are not, as opposed to where they are, control locations are assumed to be non-sites. A second assumption is that the known site locations are a representative sample of the population:

> . . .the location patterns exhibited by the initial site sample used to train the pattern classifier (the quantitative model) [must] be reasonably representative of the site population under study. The second assumption is that site locations are nonrandomly distributed with respect to the environment or social factors under investigation [Kvamme 1986 in Marozas and Zack 1987:2-2].

The basic approach to archaeological pattern recognition requires that the second assumption be made (South 1977). However, in creating the set of control points against which the site sample is checked, the second assumption is often violated in order to create a set of non-sites: "While both the SITExxx and the CNTxxx [the control points] coverages were created from the same geographic space, it was assumed that sites occur most infrequently ($p<0.01$) and with a randomized Poisson distribution" (Marozas and Zack 1987:2-5). Sites cannot be "nonrandomly distributed with respect to environment or social factors" and at the same time occur "with a randomized Poisson distribution".

The contradiction in the operational assumptions which underlie this particular approach to locational modeling renders it suspect as far as its utility to predict site or non-site locations is concerned.What is required is firm knowledge that none of the control points are archaeological sites. In our cultural resource management reports a more explicit description of areas surveyed, and sites found in them, will help alleviate this shortcoming, but when projects are done in unfamiliar areas, or when explicitly non-site locations are not available, this modeling approach seems risky. This is particularly true since the majority of locational models developed to date appear to use this technique (e.g. Marozas and Zack 1987; Limp et al. 1987; Warren et al. 1987; Warren 1988).

An alternative method has been developed by Savage (1988, 1989) that does not require the assumption of non-site locations in the model because the binary logistical regression technique is not used. Instead, site location is used as the dependent variable in a stepwise multiple regression model. The alternative method was developed primarily because information about non-site locations was not available. Assuming a representative site sample, and that sites will occur in areas that are most like those areas in which they have been found (a uniformitarian assumption), this model uses stepwise multiple regression to isolate the various environmental factors which are significant contributors to known site locations. In this case, the site location is created by assigning it a single number derived from the grid cell row and column number in which the site is located.

Once the important environmental factors are isolated, frequency distributions are run for those variables on the known site sample. The individual map overlays representing the various significant factors in the model are then renumbered to reflect the integer percentage occurrence of each variate for each factor. The Z values in the map overlays are then multiplied by the integer portion of the individual contribution of that factor to the regression model (the partial R square value). The significant layers, thus weighted, are added together, and divided by the number of sensitivity levels desired. This procedure produces areas within the project universe that are most like those that have known sites.

The procedure described above can produce values for the final model in the range of 0 to 10,000 for any given grid cell, layer, or model. For example, if the slope factor were shown in the regression model to predict 100 percent of the site location, and all the sites were on areas of zero slope, then the model would contain cells with zero values (all those with slope values greater than zero), and values of 10,000, representing all the flat areas in the map matrix. Thus the theoretical limit for any given model (and variate) is 10,000. Such a limit is not likely to occur, though, since very few situations would be expected to exist where a given variate accounts for all the variation in site location. On any given map model, therefore, the highest value may be well short of the theoretical limit.

It would be valuable if such methods could be run on more than one area, or on more than one time period within the same area, and produce results that are comparable. In this example, the results can be directly compared by converting the individual variates in any map layer to a percentage contribution to the model as a whole. It can be done by multiplying the individual variate percentage occurrence by the weight of the map layer in which it occurs (the partial R square value), and dividing the product by the highest value attained in the initial modeling operation. In this manner, the contribution of flat areas (for example) can be assessed during different time periods, or in different places, even though the model totals are not equal. The method thus presents opportunities to study cultural processes beyond simple site location modeling.

GIS Procedure-Related Studies

A few studies have been conducted on the implications of using GIS methods in archaeology, especially with respect to the accuracy of the results obtained. Kvamme's (1988) paper on "GIS Algorithms and their Effects on Regional Archaeological Spatial Analysis" is an example. Kvamme notes that

> Archaeologists are usually concerned only with the quality of archaeological data, not the quality of data obtained by computer means. In GIS environments archaeologists only are too happy to be able to obtain vast amounts of elevation, slope, aspect, and other data with relatively little effort. Seldom questioned are the validity of these data . . .
>
> As a result, in the regional distributional analysis of archaeological phenomena (e.g. various site-type and nonsite classes) against such data, different outcomes, and possibly significantly different outcomes, could conceivably be obtained depending on which GIS is used and the nature of the particular environmental estimation procedures present in each. This raises the issue of the extent to which the conclusions reached in an analysis are the result of real characteristics of the data, or of the particular computer procedures used to generate the data. A second issue raised is whether different conclusions would be reached if a different GIS package (with different algorithms) were used [1988:9-11].

Kvamme's study focused on the differences between digital elevation models (DEMS) available to the archaeologist from such sources as the U.S.G.S. and the Defense Mapping Agency. Because the models from these two agencies are available at different scales, and because different smoothing algorithms were used in their creation, different results are likely to be obtained when they are used. In particular, the small scale topographic relief that often seems to influence site location may be lost if the DEM is of low resolution, or if too much smoothing occurred. The results of a locational analysis would, therefore, be flawed if they are based on such data.

Other problems result not from the nature of the data, but from the procedures used to process data within the GIS. In working on the development of demographic models in Arc/Info, Ezra Zubrow ". . . observed while simulating alternative settlement patterns that without changing the parameters differences in resulting migrations would occur. It appeared to be a consequence of the order that one entered the initial centers or population concentrations into the networks of Arc/Info" (Zubrow 1988:344).

The problem occurs when processes which are concurrent in nature must be modeled by computers that operate sequentially. Until some procedure can be developed that will allow concurrent processes to be modeled concurrently, this problem will persist, and modelers who make use of such procedures had best take note of the difficulties. The computer's solution to the problem is not the only one available.

In the absence of truly uniform data quality standards, and in the face of problems related to concurrency, archaeologists must insert prominent caveats in their GIS based reports (especially CRM reports). Most particularly, we should emphasize the danger of reifying the results of locational analyses based on data that may not be accurate enough for the type of predictions created. In essence, the results of our location models represent hypotheses to be tested through archaeological survey, not the end product of a process that creates archaeological "facts". Many of the locational analyses using GIS have been undertaken precisely to avoid a large survey, so it appears that the use of GIS in a CRM context may result in more harm than good if compliance is assumed based on the end product of such analyses.

Beyond Locational Analysis and Problems: GIS as a Research Tool

The emphasis of Clarke (1986) and Cowen (1988) on GIS as management support tools, and the fact that many of the current GIS available have been developed by various government agencies, helps to explain why the majority of initial work with GIS in archaeology has centered on locational analysis and predictive modeling.

There is, however, great potential for using GIS as a research oriented theory building methodology in Landscape Archaeology. Before the development of GIS, many questions related to social organization and spatial clustering or territoriality could only be addressed through such techniques as spatial autocorrelation, cluster analysis, variance to mean ratios, and the like. These methods are not only difficult to implement, but even more difficult to interpret. It might well be said that the science of Landscape Archaeology was at a methodological dead-end (Paynter, Green and Wobst 1974).

The advent of GIS allows such studies to go forward under a more easily understood and manipulated methodology. Data in a GIS is automatically spatially referenced, and different themes may be explored with reference to other themes through mathematical and Boolean methods. Landscape Archaeology and GIS provide a powerful combination of theory and method that promises to advance the study of past social systems in relation to their physical and cultural environments.

Adding the third archaeological dimension of time to Berry's (1964) geographic matrix allows us to use GIS to model both diachronic and synchronic social processes. The power of GIS can be harnessed to develop more effective explanations of long-term cultural change.

> The time-depth of archaeological data naturally leads to diachronic simulation studies (e.g. Chadwick 1979). . . . For each time period under consideration a series of data themes could be developed. The themes for any time-slice could contain archaeological data, or even models of archaeological phenomena, as well as plant cover, hydrologic, and other environmental data that might vary through time. In this context any individual datum in any theme is linked not only with spatial position coordinates, but also with a coordinate that indicates locus in time. For simulation purposes GIS data management capabilities could allow access to data linked with a point in time, a point in space, to particular themes or information categories (e.g. plant cover, archaeological), or to various combinations of these factors [Kvamme 1989:35].

The use of GIS as an "engine" to drive long-term processes enabling accurate modeling has been attempted by Smith, Zubrow, and Allen (1988). Two databases were constructed, one from Africa and the other from New York State. That from New York involved the modeling of diachronic aspects of trade patterns via Arc/Info. Allen reports that, "Alternative trade models are constructed based on formalist and substantive assumptions. These models are combined with the network algorithms of Arc/Info to predict the distribution of ceramics and other trade goods. The patterns are compared with the archaeological record" (Allen 1988). The African database was used to model environmental factors leading to terrain modifications in three dimensions, over time frames varying from 2,000 to 50,000 years (Smith, Zubrow, and Allen 1988).

A further application of GIS in long-term modeling has been conducted by Zubrow (1988). In the application that first drew his attention to the problem of concurrent processes, Zubrow models the spread of colonial population through New York using the various river valleys as migration corridors. A number of different models were constructed, based on different river corridors, and their outputs compared with historical documentation. "The simulated population growth results ultimately yielded patterns of diffusion and settlement across the state in agreement with real historical occurrences, but which illustrated a pattern of migration with some spatial and temporal differences than that held by the traditional view" (Kvamme 1989:35).

The small number of such studies conducted to date, rather than discouraging the researcher, instead point the way toward research potentials in GIS applications in Landscape Archaeology which are far more exciting than the creation of simple predictive or correlation models. They show that long-term temporal, spatial, and cultural processes can modeled sucessfully via GIS methodology.

SUMMARY

Although the use of GIS in archaeological research is a new phenomenon, many researchers have begun tapping its enormous potential for storing and manipulating spatially referenced cultural, environmental, and temporal data. The bulk of work currently being done reflects the use of GIS as a management tool, for the prediction of site location in advance of project development. The various problems associated with accepting the results of such modeling episodes as archaeological facts, and the problems related to data variability, can be addressedby treating the generated models as hypotheses. This use promises, if coupled with continued archaeological survey and refinement of locational models, to allow more effective management of a shrinking cultural resource database.

Beyond the modeling,or prediction, of site location lies the potential for using GIS to examine cultural processes synchronically and diachronically, as a methodological tool of Landscape Archaeology. The methods developed in GIS, when coupled with Geographic Location Theory (Pred 1967), and the work of current revisionist archaeologists such as Bender (1978), Root (1983), Wobst (1974), Green and Sassaman (1983), and Sassaman (1983), will allow new approaches to the issues in prehistory which I find exciting.

The next two chapters of this thesis will explore social relationships among Late Archaic peoples in the Savannah River Valley by looking at the spatial distribution of sites in relation to the physical environment and other sites. GIS methods will be used to explore the existence of spatially clustered sites, and "habitual use areas" in relation to their role in the Late Archaic Landscape.

CHAPTER IV

THE PROJECT DATABASE

INTRODUCTION

The Geographic Information Systems approach which I will implement in this thesis requires that a group of Late Archaic sites be located for analysis, and that there be enough of them to provide a statistically valid sample (more than thirty). Because of both time and budget constraints normally associated with thesis research, I decided that the best approach would be to examine an existing data set, rather than seek funding for an intensive archaeological survey.

Another factor in my decision to use such a data set is related to issues of conservation archaeology. I do not necessarily believe that as archaeologists we should be constantly in the field looking for new sites, unless there is a compelling reason to do so (such as legally mandated Section 106 compliance work). Significant research can be conducted with the existing site database.

I chose to use the Late Archaic sites located during the archaeological survey of the Richard B. Russell Reservoir project area (Taylor and Smith 1978) for these reasons. One other benefit was that I am familiar with the project area, having participated in other projects in the Russell Reservoir (Warner and Savage 1979).

This chapter will provide a brief description of the Russell Reservoir project area and its environment. It is not my intention to discuss these matters exhaustively; for a more detailed description, the survey report by Taylor and Smith (1978) may be consulted.

Following the environmental section I will describe the database for this project, and will discuss the site survey methods used by Taylor and Smith.

THE RUSSELL RESERVOIR PROJECT AREA ENVIRONMENT

The Richard B. Russell Reservoir is located on the Savannah River, between Lake Hartwell to the north and Clark Hill Lake to the south (Figure 1).

> The dam is located 29.9 miles below Hartwell Dam, 37.4 miles above Clark Hill Dam, and 275.1 river miles above the mouth of the Savannah River. At this site the river flows on bedrock at an elevation of 300 feet above mean sea level between steep valley walls that rise from the water's edge to 442 feet on the left bank and 441 feet on the right bank. Above these elevations, gentle slopes rise to the uplands at elevations 500 to 520 feet on the downstream end of the project. Near Hartwell Dam, upstream, the fairly flat uplands are found at about 600 feet [Taylor and Smith 1978:1].

The project area is entirely within the Piedmont physiographic province (Fenneman 1938). Taylor and Smith, citing Fenneman (1938), and Ireland, Sharpe and Eargle (1939), have noted that the Piedmont is characterized by gently rolling hills, without sharp breaks between hilltops, slopes, and river valleys (1978:4). Significantly, they add, "Because of this, it is often difficult to objectively define on-site landform" (1978:4). The Piedmont province is thus amenable to analysis by Geographic Information Systems methodology, since GIS does not rely upon notions of landform. Rather, discrete geographic variables are used to differentiate location.

Two major divisions in the Piedmont Physiographic Province are the Riverine and the Inter-Riverine zones (House and Ballenger 1976; Goodyear, House and Ackerly 1979). The Inter-Riverine zone is generally associated with broad, gently sloping to flat upland areas between the major rivers of the Piedmont. In contrast, the Riverine zone is associated with floodplains and valley bottoms. Goodyear, House and Ackerly have, however, noted a problem related to defining the Riverine zone:

> One of the current difficulties or limitations in our settlement analyses of the Piedmont in general, however, is the differentiation of the province by only two crude units, "riverine" and "inter-riverine". While certainly the distinction between the two as they might relate to aquatic and/or riparian habitats versus terrestrial habitats is meaningful at some level, as presently distinguished, it is difficult to relate variability in environmental zones to variability in settlement. The term "riverine", for example, does not discriminate between a large rank drainage such as the Savannah River and a small seasonal creek located ten miles away. Furthermore, the term "inter-riverine" most certainly denotes an area between two rivers, but which two rivers? [1979:131].

In spite of the problems congruent with clearly defining areas as Riverine or Inter-Riverine, it is possible to associate certain plant and animal communities with areas which are clearly aquatic/riparian versus terrestrial habitats.

The upland, Inter-Riverine ecozone was originally covered with a mixed pine-hardwood forest:

> Upland areas with good soils supported white oak communities (*Quercus alba*), various species of hickory (*Carya sp.*), post oak (*Quercus stellata*), numerous other oak species, blackgum (*Nyssa sylvatica*) and persimmon (*Diospros virginiana*). A post oak community comprised of *Quercus stellata* and *Quercus alba*, is present with *Pinus echinata* [short-leaf pine] and other varieties of oak and hickory also associated. This community tends to be found in the poorer and drier upland areas and is more common than the white oak community. Excessively drained and leached drainage divide soils produce a poor community of stunted open blackjack oak (*Quercus marilandica*) and post oak mixed with other members of *Quercus* and *Carya*. Eastern red cedar (*Juniperus virginiana*) and short-leaf pine (*Pinus echinata*) also occur here [Goodyear, House, and Ackerly 1979:17; Whitehead and Barghoorn 1962:349].

The availability of many species of oak and hickory in the Inter-Riverine, upland areas of the Piedmont was important to the peoples living in the Savannah River Valley. House and Ballenger (1976) have found numerous small sites in this ecozone, related either to direct exploitation of the mast producing species, or to hunting the white-tailed deer that congregate there during the fall months to feed on the acorns and hickory nuts. House and Wogaman (1978) found hickory nuts and acorns at Windy Ridge, a site in the Inter-Riverine zone in South Carolina. On most sites of the Late Archaic period, plant food remains consist mostly of hickory nuts, with acorns second in abundance (Yarnell 1974:109; Wagner 1979:31; Chapman 1973:123). Shagbark hickory nuts yield 25 to 38 pounds of meat for each 100 pounds of nuts; shellbark hickory yields 15 to 25 pounds; white oak acorns yield 60 to 90 pounds of meat for each 100 pounds of nuts (USDA 1948:110, 203, 301). They were thus able to provide an important dietary staple to Late Archaic peoples.

I have already mentioned the abundance of white-tailed deer in the Inter-Riverine zone. Other significant species (those that may have been economically attractive to aboriginal populations) include the black bear, gray squirrel, fox squirrel, eastern chipmunk, and opossum.

In contrast to the upland areas, Riverine habitats:

> . . . are characterized by willow oak (*Quercus pellos*), sweet gum (*Liquidambar styraciflua*), tulip tree (*Liriodendron tulipifera*), blackgum (*Nyssa sylvatica*), hackberry (*Celtis occidentalis*), and species of oak, hickory, walnut, willow, elm, maple and beech. House and Ballenger (1976:11) noted that water oaks (*Quercus nigra*), a more southerly species, were abundant in bottomland habitats in the area of the I-77 corridor [Goodyear, House and Ackerly 1979:17].

In addition to the terrestrial plant species found in the Riverine zone, important aquatic plants present seasonal resources which can be exploited. These include cattail, duck potato, bulrush, wild rice, sedge, parsnip, and waterleaf.

Terrestrial fauna which may be found in the Riverine ecozone include the white-tailed deer (though probably not in as great abundance as in the upland habitat), raccoon, beaver, muskrat, weasel, several species of turtles, and various amphibians. Aquatic species include various mussels, snails, freshwater and anadromous fish. For an extensive discussion of the role of various aquatic and terrestrial plant and animal species in the diets of aboriginal peoples, Keene (1981a) and Taylor and Smith (1978) may be consulted.

One of the major problems associated with reconstructing the past environment is that the aboriginal forests no longer exist:

> . . . the contemporary vegetation of the Piedmont and the project area has been greatly modified by clearing of the forests and agriculture, and the erosion that followed. In addition, national economic forces have conspired within the last forty years to make the area economically marginal. The result of this has been to return most of this area to forest, but not the forests that we have been discussing. Substantial portions of the project area are pine plantation or mixed pine and hardwood communities in the middle stages of old field succession. Very little of the land is used for agricultural purposes. Consequently, the project area contains a mosaic of vegetation types that reflect primarily modern activities [Taylor and Smith 1978:27].

In terms of the present project, this difficulty means that I cannot make use of land use and land cover maps to reconstruct an aboriginal environment. They are based on data from contemporary satellite imagery that reflects modern economic activities, as Taylor and Smith have noted.

THE PROJECT DATABASE

Taylor and Smith located fifty-three Late Archaic sites during their survey of the Russell Reservoir. I have used fifty-one of these as my data set. One of the omitted sites had no UTM coordinates, so it was not possible to locate it. The other site dropped from the data set was about nine kilometers north of the remaining sites; its inclusion would have required creating a larger scale GIS map matrix. Since the accuracy of the GIS approach is related to the size of the grid matrix, I chose to drop this site in favor of a smaller map scale. The immediate project area for this thesis was created by taking the sites with extreme directional coordinates as the extent of the site scatter, and then adding two kilometers in each direction and rounding to the next highest whole kilometer. This resulted in a project area of approximately twenty kilometers east/west by thirty-one kilometers north/south, and a map scale of 127 meter grid cells.

The primary data from the sites may be found in Taylor and Smith (1978) and in the site files at the South Carolina Institute of Archaeology and Anthropology in Columbia. It was to these two sources that I turned in order to construct a database for this thesis. Environmental data published on the sites in Taylor and Smith (1978) include site number, estimated size, cultural affiliation, current land use, current vegetation, landform, project location, site type, eligibility, and the like (1978:Appendix A). Of these variables, only the site number, size and cultural affiliation are immediately usable in this project, since most are either current conditions or variables such as landform. I have already noted the difficulty the authors had with distinguishing on-site landform, and that their data categories are nominal level variables which are not suited to the level of analysis which this project performs.

Appendix B of Taylor and Smith lists artifact assemblages for the sites found during the survey. These include quantities of hafted bifaces, other bifaces, unifaces, bifacially retouched flakes, other flakes, chunks, miscellaneous lithics, hammerstones, groundstones, lithic raw material types, and prehistoric ceramics. During the analysis phase of this project, reported in Chapter V, these lithic data will be used, along with site size, to differentiate site function based on attributes of space, time and form.

It is highly unlikely that all of the Late Archaic sites recovered during the Russell Reservoir survey are contemporary. We define the Late Archaic as a period of two thousand years or more; it would not be reasonable to assume all sites were in use at the same time, and were, therefore, parts of one settlement system. Equally obvious is the fact that the larger sites may represent palimpsests of recurring activities that are not contemporary.

However, as long as we have archaeological sites within a circumscribed area, and within all of the ecozones within that area, we can approximate a settlement system from those sites. In doing so we must understand that known, existing sites in each ecozone present only a portion of the unknown or destroyed sites in the same ecozone. For the approximation of a Late Archaic settlement system, though, it is not particularly critical that all the sites be absolutely contemporary. The database must be understood as containing a cross-sectional sample (rather than a cohort sample) of the population of sites which reflects both the full range of activities that occurred and the full range of ecological zones. Even though all the sites may not have been in use at the same time, they are like others that were, so a settlement system may be approximated.

The accuracy of the settlement system depends upon the nature of the data collection strategy. In the following section I will review the field methods used by Taylor and Smith during the Russell Reservoir survey project.

SITE SURVEY METHODS

During the survey phase of the Russell Reservoir project, the two principal authors of the report (Taylor and Smith) functioned as crew chiefs. Each crew consisted of the chief and two archaeological technicians. Taylor and Smith divided the project area along the length of the Savannah River, and each crew chief was permanently responsible for the survey of one side. The technicians rotated across the Savannah River every two days, and constant communication and "visits" across the river enabled both crew chiefs to maintain a consistent approach to the survey methodology.

The actual survey of the reservoir area was conducted with both probabilistic and non-probabilistic methods. Taylor and Smith describe the probabilistic method as follows:

> The Savannah River (starting at the dam site) and the major tributaries (starting at their confluence with the Savannah) were divided into one kilometer segments. Each of these one kilometer segments was further subdivided into ten one hundred meter intervals. From each segment, two intervals were randomly selected as the origins of random vectors. One vector was plotted to the left of the segment line, the other to the right of this line. The azimuth of a vector was also randomly selected from within a range of 10 degrees to 170 degrees using the segment line as the 0 to 180 degree axis. These vectors were the centerline of a transect one hundred meters wide and one kilometer long. One hundred sixty transects were plotted in this way. This design has the effect of dispersing the sample over the entire project area and insuring that the total range of landforms present would be encountered . . .
>
> The transects were supposed to be inspected by having the survey team walk three abreast about fifty meters apart with the center person using a compass to maintain the proper azimuth. Crew members were walking in a zig-zag manner, looking for disturbed ground. This was to be done for the length of the transect with crew members noting especially favorable locations for subsurface testing. Then the transect was to be subsurface tested at fifty meter intervals or in favorable locations as the crew moved back to the transect origin. If sites were encountered, they would be collected and recorded. If artifacts were recovered in a subsurface test, then a cruciform subsurface testing procedure was to be used to determine site extent. Two of these [transects] were to be done per crew per day [1978:180, 182].

However, because of the limited visibility associated with the extremely thick vegetation in the survey area (second growth pine/hardwood forests with thick vines and kudzu understory), and the rugged nature of the terrain, the survey methodology was revised in order that a schedule might be maintained, the survey completed, and time remain in the budget for additional testing. Also, the authors noted that sites were not being found during the subsurface testing in the transects, but instead they were found "in roads, agricultural fields, and logged areas that were intercepted by a transect . . . or, once a transect had been completed, on the way back to the truck" (1978:182).

For these reasons the probabilistic survey was abandoned in favor of a non-probabilistic approach that placed the survey emphasis on accessibility and visibility of the ground surface:

> Our strategy was to favor accessibility first and then visibility. As a result many roads were walked that were nearly overgrown. Old roads are, of course, prime indicators of past land use either for domestic, agricultural, or logging purposes. Often these roads would lead to areas that had been cleared and had at least patchy visibility that would permit, in some instances, a fairly reliable determination of the presence, and especially, absence, of sites.
>
> In addition to roads which tend to be transect-like in shape, it was possible to inspect logged areas that had not been replanted. Visibility was variable in these areas and a function of the length of time since the logging was done. Agricultural fields were also inspected and these too, varied in visibility because of the time of year the survey was performed from fallow fields to abandoned cornfields covered with a carpet of Bermuda grass. Pastures were also inspected. . . . Inspection of these areas gave us samples that were much more landform extensive than those obtained by walking roads [1978:183].

Because of the authors' abandonment of the probabilistic sample in favor of one more conducive to accessibility and visibility, two questions must be asked with respect to the Russell Reservoir survey data: Does the data recovered reflect a random sample of the project area, and is the sample statistically valid for re-creating a settlement model? As Taylor and Smith have noted:

> The strongest rationale for probabilistic sampling is that when effectively used, it recovers a representative sample of the population of interest [that is, a statistically valid sample]. The problem is how to evaluate how effective a particular design is in yielding reliable estimates. It appears, that at the present moment, this is difficult to do and often requires comparison with the known populations which are, of course, rarely available because that is why sampling is done in the first place (see Judge, et al. 1975).
>
> The areas selected for survey in terms of accessibility and visibility could also be thought of as a possible random sample of the area, though this would need evaluation, which is not presently possible. Most of the proscriptions against nonprobabilistic sampling derive from investigators in areas where visibility and access problems are minimal and these investigators are rightly complaining about others who choose areas by "judgment" or "intuition" (Redman 1975). A conscious attempt was made to minimize the role of judgment and intuition as a basis for selecting areas of inspection. The accessibility and visibility conditions in the project area were determined independently of archaeological concerns, and because of this a reasonable argument can be advanced that these are "random" with respect to the investigator's possible interests [Taylor and Smith 1978:184].

Since the authors affirm the randomness of the survey in the sense of landforms covered, we are able to address the issue of approximating a Late Archaic settlement system.

SUMMARY

This chapter has presented an overview of the Richard B. Russell Reservoir area in terms of its topological, floral, and faunal environments. It has not been my purpose here to provide an exhaustive description of these environmental factors, since that has already been done in the excellent overview to be found in Taylor and Smith's (1978) report on the Russell Reservoir survey project.

Fifty-three Late Archaic sites were found during the survey of the reservoir area prior to its inundation, and fifty-one were selected for analysis through Geographic Information Systems methodology. I have noted that the project survey methodology presents some problems that require a particular approach to the data set, specifically the generation of a settlement system based on what must be considered as a cross sectional site sample, and one that represents a palimpsest of activities in the project area.

The next chapter will use GIS methodology to explore the Late Archaic landscape in the project area. A hypothesis developed from current revisionist approaches to the past will address the existence of social territories. Several analytical techniques, including Nearest Neighbor analysis, artifact variability analysis, and the Map Analysis Package GIS will be used to explore test implications derived from the hypothesis.

CHAPTER V

LOOKING AT THE LATE ARCHAIC LANDSCAPE

INTRODUCTION AND THEORY RECAPITULATION

In this chapter Geographic Information Systems methodology, and a number of different statistical techniques, will be brought to bear on test implications developed from an hypothesis about social organization in the Late Archaic. Several bridging arguments, or assumptions, will be advanced in order to connect the hypothesis, which cannot be tested directly, to the test implications, which can.

In Chapter II the Landscape Archaeology paradigm was introduced as a means of uniting several different approaches to prehistory into one coherent whole that considers as its problem domain the interaction of people with their physical landscape, their cultural landscape, and their cognized models of both. A paradigm so constructed has the power to offer explanations of social organization, land use, site location selection, site variability in relation to the cultural and physical environments, issues related to boundary formation and maintenance, subsistence modes, and movement models such as forager or logistic collecting.

In addition, because it recognizes the role of the cognized environment, both physical and cultural, Landscape Archaeology is able, through such constructs as Pred's Geographic Location Theory, to take an actor-centered approach to the past. Such an approach creates a dynamic understanding of past cultural systems, since it allows conflict and resolution, control and manipulation of information, and various abilities of the actors involved to actively change the landscape. Change thus becomes a product of the normal functioning of past cultural systems, not a phenomenon which cannot be explained. Change may be seen as the lifeblood of cultural systems; a society which does not change quickly stagnates and dies. Change is, in fact, the only constant.

> Not only is all human reality culturally comprehended (cognized), but it is in constant flux, as people in groups, acting on the basis of vested interests that make it attractive to perceive the environment in specific ways, expend energy in ways that, in turn, affect and come into conflict with the results of past social actions, energy expenditures, and perceptions . . . .
>
> Contradictions inevitably arise as humans interact with their cognized environments. <u>Within</u> human groups contradictions result from differential participation of people in the development of models of reality. <u>Between</u> human groups contradictions emerge because people occupying particular localities develop models of their environments based on their specific needs and experiences; these models may be at variance with those of other groups, leading to competition over scarce resources, religious conflicts, and the like. Contradictions constitute the raw material of change, which occurs in the resolution of conflicts and tensions between and among human groups, and between human groups and the physical environment [Marquardt and Crumley 1987:5-6].

Since contradictions and conflicts between and among human <u>groups</u> constitute the raw material of change between those groups and their physical, cultural, and cognized environments, one of the high priorities in the Landscape Archaeology paradigm must be the study of those human groups and their environments.

Initially, then, we must ask the question, "What are the likely human groups involved, and how are they located in the environment?" Once we can approach an answer to this question we can begin to examine group interaction, speculate on the nature of within and between group conflict and resolution, and so come to a better understanding of contextualized culture change, as those conflicts are resolved in particular ways, in particular times and places.

Several models of European prehistoric social organization were examined in Chapter II. These included Wobst's simulation study of Steward's (1969) minimum and maximum bands, and Dennell's parallel concept of subsistence and reproductive groups. Clark's notion of social territories fits well with Wobst's assumption that human groups occupied particular places, and extracted their resources in the surrounding territory as a matter of habitual use. We have seen an ethnographic example in the !Kung (Marshall 1959 in Moore 1981). Groups are presented with difficulties related to information about, and/or permission to extract, resources from a strange territory (one that is the "habitual use area" of another group). The ethnographic reality corresponds to our understanding of Pred's Behavioral Matrix.

Models such as these have heretofore not been applied to the Late Archaic in the Southeast. I have noted in Chapter II that research in this period has tended to focus on the relative importance of various items in the Late Archaic diet, and on exploitative mechanisms for obtaining those resources.

What gets lost in this kind of traditional research is the emphasis on people, the emphasis on within and between group conflict and resolution, and the emphasis on change mechanisms. In short, what gets lost in the research are exactly those things that make the Late Archaic such a dynamic period for anthropologists. An argument over the relative importance of shellfish in the Late Archaic diet cannot begin to address the fascinating changes which archaeologists observe in the period, that have been outlined in Chapter II. By introducing the human element, through an hypothesis related to the existence of social groups in the Late Archaic, I hope to re-direct the discussion to the more interesting issues.

THE LATE ARCHAIC SOCIAL LANDSCAPE MODEL (The Hypothesis)

Based on the works of Clark, Wobst, and Dennell in European Prehistory, the hypothesis which will be considered in this chapter may be stated as follows:

The Late Archaic Social Landscape consisted of Maximum Band Social Territories, divided into Minimum Band Subsistence Territories.

Because the hypothesis cannot be directly tested, it is necessary to develop test implications derived from assumptions and bridging arguments, and that are likely to be demonstrable if the hypothesis is true. Eight such statements will be presented below.

BRIDGING ARGUMENTS (Assumptions)

1. The Late Archaic Landscape reflects the patterned behavior of Late Archaic Social Groups.

2. The archaeological record preserves a sufficient amount of that patterning, in material and spatial relationships among sites, artifacts, and features, that an understanding of the patterned behavior may be approached.

3. The function of archaeological sites in the past cultural system may be understood by analyzing them along the archaeological axes of space, time, and form.

4. The Late Archaic Landscape included people using sites in "Habitual Use Areas".

5. Sites identified as Base Camps (based on analysis of space, time and form) form the centers of "Habitual Use Areas".

6. The boundaries between Habitual Use Areas may be either edges or centers, but, in either case, least cost movement across the physical landscape must be considered during boundary formation.

7. Following figures summarized in Hassan (1981:Table 2.1), the population density of Late Archaic hunter/gatherers is assumed to be in the range of .39 to 1.2 people per square kilometer. Minimum band size is assumed to range from 20 to 120 (taking into account ethnographic examples and Perlman's (1985) discussion of the unrealistically low estimates for such groups). Maximum band size is assumed to range from 200 to 600, based on Wobst's simulation and Perlman's cautionary note.

8. The spatial orientation of Late Archaic Habitual Use Areas will reflect known patterns of Late Archaic land use.

<u>Discussion</u>

The first three assumptions, that human behavior is patterned, that the archaeological record reflects the patterned material and spatial remains of that behavior, and that function can be determined based on the analysis of space, time, and form, are basic archaeological "givens". We assume them to be true because if we did not there would be no material basis for doing archaeology.

The assumption of "Habitual Use Areas" follows Wobst and Dennell:

> Paleolithic social groups are territorial. "Territorial" implies that the members of a given social group moved within an area which was more or less delineated by social factors, by the proximity of other such groups, by considerations of distance, by familiarity with the environment, and by natural obstacles. . . . The "territory" of these groups is usually not maintained through an exclusive claim <u>but by habitual use</u> [Wobst 1974:151-153; emphasis mine].

In addressing the same issue, Dennell writes, "A subsistence group should also be associated with an annual territory: that is to say, with an area that it and neighbouring groups will recognize as containing its food resources" (1983:12). In addition, we have the ethnographic example of the !Kung discussed previously. It seems, therefore, a safe assumption that such "Habitual Use Areas" existed in the Late Archaic.

The placement of a base camp at the center of an habitual use area is based on principles developed from site catchment analysis. Vita-Finzi and Higgs (1970:5) define this term as "the study of the relationships between technology and those natural resources lying within economic range of individual sites." Roper notes that, "The study of Higgs <u>et al.</u> (1967) and Vita-Finzi and Higgs (1970) exemplify the two techniques most commonly used for delimiting the territory to be examined in site catchment analysis -- namely, the use of circular territories of fixed radii and the use of time contours" (1979:123).

The oft-cited observation of Lee (1968), that the !Kung San do not normally range further than six miles (ten kilometers) from their base camp in search of resources has formed the basis of much catchment research in archaeology. The actual distance traveled in search of resources will depend on topographic features which enhance mobility, such as a flat, treeless plain, or reduce mobility, such as a Piedmont environment with many small streams and rivers to cross. In either case, though, the position of a base camp at the center of the catchment is assumed.

The fact that the environment, especially topography, vegetation, and hydrology, influences the distance that can be traveled has caused the one or two hour walk method of catchment analysis to be preferred. This is simply a technique for compensating for environmental variation. The principle of least cost movement is thus factored into catchment analysis. With the advent of GIS, a more direct method is available. This method measures distance from certain features, such as base camps, by calculating for the effects of moving over topography and through hydrology. The GIS method insures that least cost measures are included in the consideration of boundary formation.

The boundaries between habitual use areas, following Marquardt and Crumley (1987), may be either edges or centers, depending on the people looking at the boundary. For example, on the one hand, individuals or groups that are not involved in inter-group communication or exchange are likely to view the boundary as an edge that separates their group from another. On the other hand, people who are involved with inter-group activities are likely to view the boundary as a center for those activities. A potential source of conflict is thus presented between the two differing cognized views of the boundary zone.

TEST IMPLICATIONS

Two sets of test implications may be derived from the hypothesis and the bridging arguments. The first set is general in character, having to do with the nature of habitual use areas, including the types of sites likely to be found in them, and the groups that lived in them. The General Test Implications include the following:

1. The distribution of Late Archaic sites in the project area is clustered, rather than random or regular.

2. A variety of site types, reflecting different temporal, spatial, and functional uses, will occur in each cluster.

3. The habitual use areas in the project area reflect the activities of minimum bands, rather than maximum bands.

4. The boundaries between habitual use areas will reflect uses both as edges and centers.

The second set of test implications is specific to the Late Archaic period in the Southeast. Two implications may be derived from the hypothesis and the assumption that the spatial orientation of habitual use areas in the Late Archaic period will reflect known patterns of Late Archaic subsistence.

5. Sites will be located along the stream and river system in the project area.

6. Habitual use areas will straddle the major drainages in the project area, and will be bounded by other topographic features such as ridgetops or minor drainages.

ASSESSING THE TEST IMPLICATIONS

Each of the six test implications will be assessed in turn, beginning with the general implications. A variety of statistical techniques and Geographic Information Systems methods will be employed, as appropriate. In this section of the thesis I will include only a summary discussion of the GIS methods used to generate the maps which I will present. A more detailed discussion will be presented in Appendix B, Creating the Map Overlays. The statistical techniques involved are straightforward enough that a summary discussion of their application in this part of the text is all that is required.

Test Implication #1: **The distribution of Late Archaic sites in the project area is clustered, rather than random or regular.**

The Nearest Neighbor Statistic (Johnston 1984) will be used to test the nature of the site distribution in the project area (Map 1). Johnston notes that the value of the Nearest Neighbor Statistic, R, "ranges between 0.0 and 2.1491: 0.0 indicates a totally clustered pattern of points; 1.0 indicates a random distribution . . . and 2.1491 a uniform distribution" (1984:220). He gives the formula as follows:

R = rA / rE

where rA is the mean distance from each observation . . . to its nearest neighbor; and

rE is the expected mean distance between each observation . . . and its nearest neighbor, assuming that the N observations are randomly distributed in the given area, i.e.

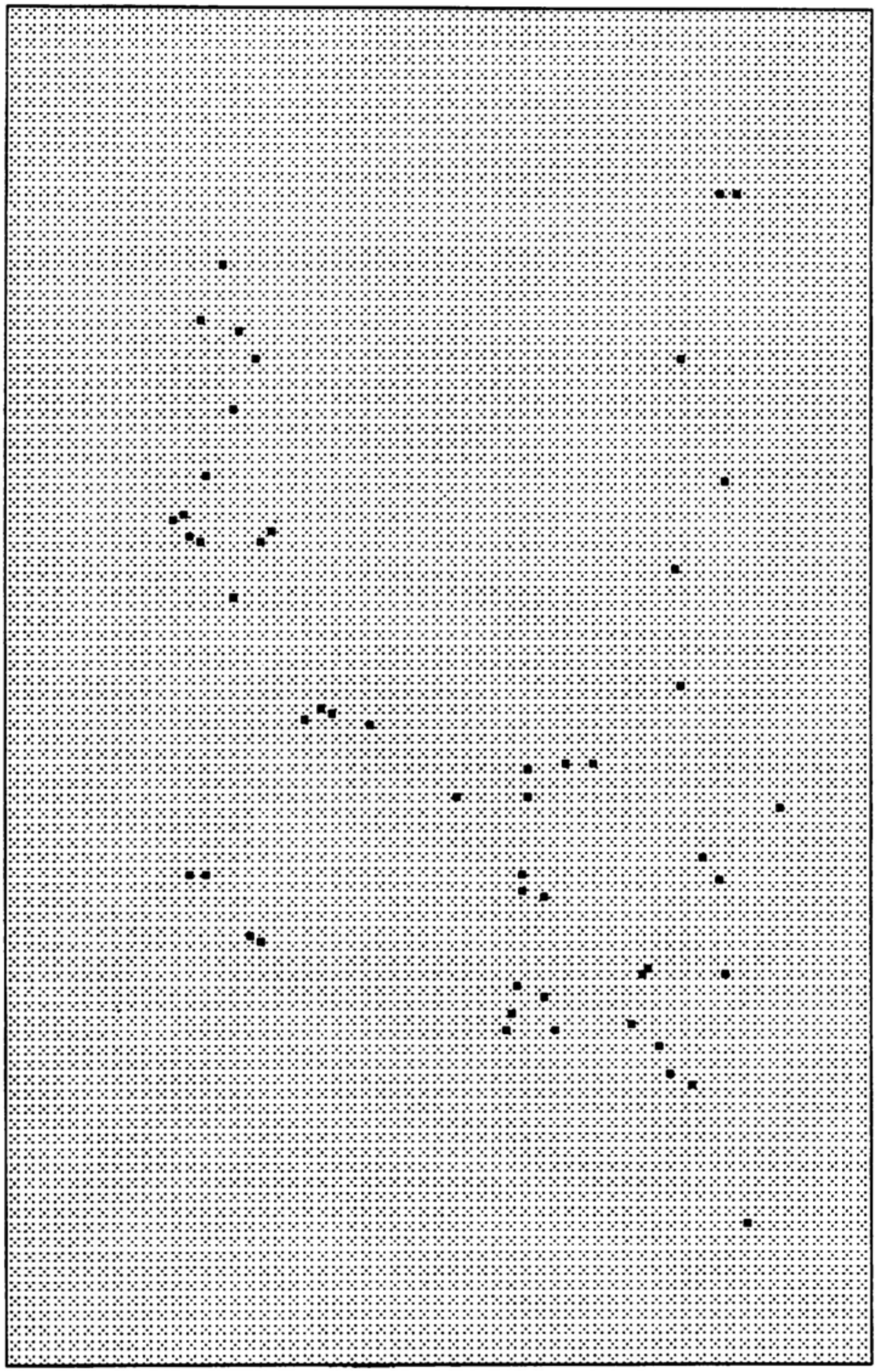
rE = (1 / 2(square root P))

where P = N / total area or volume.

To operationalize the Nearest Neighbor Statistic, the mean Euclidean distance from the fifty-one site location centers was calculated by averaging the distance from each site to its nearest neighbor (see Appendix A, Table 1 for exact distances). In this case, the mean distance, rA, is 855.71 meters for N = 51 sites. The size of the project area is 20 * 31 kilometers, or 620 square kilometers; P therefore equals 51 / 620, or .082. The expected value, rE, equals 1 / (2 * square root P), or 1 / .573; thus rE = 1.75. The value of the Nearest Neighbor Statistic, N, = rA / rE, or .85571 kilometers (it is necessary to convert all distance measurements to the same scale) divided by 1.75; R = .489, indicating a distribution that tends to be clustered.

A problem with the use of the Nearest Neighbor Statistic is related to the size of the area used to calculate P. The same set of points will tend to be clustered if P is larger (if the area including the points is large), or will tend to be random if P is small. Gettis and Boots (1977) suggest that one way to eliminate this problem is to position the sample area within the total cluster of points, that is, to create, for the purposes of the test, a smaller area.

To address this problem it is, therefore, necessary to define a smaller window within the project area. The window was calculated by eliminating two site locations on each of the four sides of the project area. These locations were the sites with the two most extreme UTM coordinates in each direction.



Map I: Late Archaic Sites in the Richard B. Russell Reservoir Project Study Area.

For example, the two sites in the sample that are farthest south are 09EB255 (UTM Northing = 3767200) and 38AB010 (UTM Northing = 3770300). The southern boundary of the new test region was then calculated by averaging the Northing UTM reading for the second site (38AB010) and the third site (38AB213). Following this strategy for all sides of the project area results in a test area of 19.58 by 12.93 kilometers, or 253.17 square kilometers. Seven sites were eliminated in this manner. (One site, 09EB255, was located near a corner of the site distribution, and was eliminated twice, making a total of only seven sites actually eliminated).

In this second case, rA is 799.36 meters for N = 45 sites. P = 45 / 253.17, or .1777; rE = 1.186. The Nearest Neighbor Statistic equals .674, indicating a distribution that is tending toward random, but is still somewhat clustered.

Thus, regardless of which area P is chosen, the distribution of sites in the project area is clustered, rather than random or regular. The fact that the entire project area will be used for further GIS analysis indicates that the .489 figure is a more accurate reflection of the site distribution than the .674 figure calculated on a truncated window of the entire project area. Test implication number one, therefore, has been demonstrated.

<u>Test Implication #2:</u> **A variety of site types, reflecting different temporal, spatial, and functional uses, will occur in each cluster.**

There are several steps involved in assessing this test implication: 1) the sites and artifacts need to be analyzed, and site functions assigned, based on the archaeological axes of form, space, and time; 2) least-cost movement ranges, centered on base camp locations, need to be calculated, taking into account the project area topography and hydrology; 3) once these distances have been determined, the project area may be divided into Thiessen Polygons (Gettis and Boots 1977:126-128, 135-142), representing habitual use areas; and 4) a site type distribution overlaid on a map of the polygons will allow this test implication to be assessed by inspection.

Step 1: Determining site function based on form, space, and time

The artifacts collected during the survey and testing of the Russell Reservoir are currently in Alabama, and so were unavailable for study; this phase of the project had to rely on published artifact inventories. Besides the inventories listed in the Appendices of Taylor and Smith (1978), additional inventories are available in White's (1982) and Sassaman's (1983) theses, and collections recovered during testing are published in Goodyear, Monteith and Harmon (1983). Unfortunately for this analysis, not all the artifact categories from the various inventories include the same artifact types. Several types in Taylor and Smith overlap other types in White and Sassaman, and several of their types do not occur in Taylor and Smith. Taylor and Smith generally present category totals higher than those in White's or Sassaman's theses. This may be because of having recognized fewer artifact categories, but also possibly because of attrition that may have occurred in the artifact collections as a result of multiple analyses over a period of several years. Only eight of the fifty-one Late Archaic period sites were tested and reported in Goodyear, Monteith and Harmon, though their artifact types are closer to those used in Taylor and Smith. For these reasons, the artifact inventories listed in Taylor and Smith (supplemented by the testing results from Goodyear, Monteith and Harmon) will be used to conduct a basic analysis of tool type and lithic raw material variation.

The analysis of tool type variability in the site inventories will provide control over the archaeological axis of form, through the use of a technique similar to that developed by Fish (1976), and subsequently modified by Watson (in Garrow et al. 1979).

> The purpose of the Index of Variability and Function is to differentiate between special usage sites, such as quarries or hunting camps, and villages or long term camps in a manner that is replicable and quantifiable rather than subjective or based on the presence or absence of a single artifact type such as ceramics. . . . It is possible using the Index of Variability and Function to infer site function or intrasite activity areas by use of functional categories defined from specified artifact traits [Watson in Garrow et al. 1979:103].

The Index of Variability and Function is based on thirty artifact types which are assigned to one of six different functional categories. The specific index of variability for a given site is simply a percentage of the thirty types present, that is, I.V. = X / 30. Each index of function is calculated in a similar way, based on the number of tool types in each category present at a site, divided by the total number of types in the category. "The Index of Variability is used to indicate a range of activities which are likely to have occurred at a given locus, with a higher I.V. indicating more diverse activity and a presumed longer or more diverse site usage" (Watson in Garrow et al. 1979:103). The use of the Index of Variability can help determine whether one is dealing with an extractive site or a maintenance site, based on the number of different tool types present. Small numbers of different tool types present tend to indicate an extractive site, while a wide range of types is more indicative of a maintenance camp (Binford and Binford 1966).

Unfortunately, for the current project, the tool types listed in Taylor and Smith's artifact inventories could not be made to coincide with those in the index, as developed by Fish and Watson. Only nine lithic tool types are included in Taylor and Smith (1978:Appendix B). These include hafted bifaces, other bifaces, unifaces, flakes of bifacial retouch, other flakes, chunks, other lithics, hammerstones, and ground stone. It was necessary to create an index of variability based on the presence or absence of these nine tool types.

Accordingly, the number of categories present in each site inventory was divided by nine to create the Index of Variability (see Appendix A, Table 1, Variable IVAR) for each site. For the purposes of further analysis, Extraction sites are judged to be those with five or fewer tool types present, or an Index of Variability of .56 or less. Maintenance sites, in contrast, have six or more tool types, and an I.V. of .67 or greater. The variable IVARGRP (Appendix A, Table 1) was assigned on the basis of this division.

The temporal axis was addressed in a similar manner, though instead of considering tool types, lithic raw material variability was used to create an "Index of Connectivity". Five "exotic" lithic materials are listed in Taylor and Smith's Appendix B: 1) Coastal Plain Chert; 2) Slate; 3) Ridge and Valley Chert; 4) Steatite; 5) Other. In addition to these five, one other category was created to handle sites where no exotic materials were present, making a total of six lithic material categories. This category was assumed to be present at all sites, since artifacts are reported even when there are no exotic raw materials present, and it is highly unlikely that all the lithics present at a given site are exotic. (Taylor and Smith do not supply the actual numbers of exotic specimens from each site, only the presence or absence of the material).

An "Index of Material Connectivity" value was assigned to each site (Appendix A, Table 1, Variable IMAT), and an IMATGRP variable assigned based on the values of IMAT. IMAT values of .50 and lower were assigned a "Poor" IMATGRP classification; values higher than .50 received a "Good" classification.

The value of this measurement is that it serves as an indicator of long range spatial processes, in that exotic raw materials must come from some distance. Sites with many different types of exotic lithic material thus demonstrate a "connectedness" to outside raw material sources that other sites do not. The measurement also serves as an indicator of long-term processes occurring at a site, since that connectedness is more likely to develop at sites used over long periods of time (whether permanently occupied or used repeatedly, year after year, as seasonal base camps). When several different kinds of exotic raw materials are present at a site, Goodyear, Monteith and Harmon suggest that it represents:

> . . . prolonged usage or successive occupation because non-quartz [the local raw material], especially non-Piedmont lithic raw material, constitutes a minority proportion of artifacts of chipped stone forms in the Piedmont. Sites that possess large numbers of such specimens would require occupation spans that were longer than most sites in the Piedmont that typically do not have exotic artifacts [1983:17].

These two indices therefore provide a means to control the archaeological axes of time and form. The third axis, space, may be controlled by considering the site size. The sizes of the sites in the project area were estimated by Taylor and Smith (1978). They have been copied into Table 1 (Appendix A), directly from the survey report, except for the sites tested by Richard Taylor and Timothy Seaman, and reported by Goodyear, Monteith and Harmon (1983). If the site size differed from that in Taylor and Smith, the one reported during testing was used instead. For the purposes of this analysis, sites were grouped into large and small categories (Table 1, Variable SIZGRP). Large sites included those of 7,500 square meters or greater, small sites are under 7,500 square meters.

Eight possible combinations of the three variables measuring space, form, and time are possible. To test whether all eight combinations were viable, Chi-square tests were run on the categories.

The first two tests checked whether the site size was associated with high or low measurements of the other two variables. In the case of the table of SIZGRP by IVARGRP, or size by tool type variability, the Chi-square value was 1.399, not significant at the .05 alpha level (Appendix A, Table 2). For the test of SIZGRP by IMATGRP (size by lithic raw material variability), Chi-square was 1.996, again not significant at the .05 level (Appendix A, Table 3). Since neither of these variables are directly associated with either small or large sites, the size variable cannot be eliminated from the consideration of site function. We will have to think in terms of large and small sites with high and low values for the other two variables.

In contrast, a Chi-square test run on the table of IMATGRP by IVARGRP (index of connectivity by index of variability) demonstrates that good connectivity is associated with maintenance sites and poor connectivity with extraction sites (Chi-square = 16.176, p = .000).

On the basis of these tests, it appears that the eight possible site types, based on three variables with two variates each, are viable. Table One summarizes the different site types developed from the eight permutations (see Appendix A, Table 1 for site designations).

Table One: Site Types Based on Analysis of Space, Time, and Form

SIZGRP (Space)	IMATGRP (Time)	IVARGRP (Form)	Site Type
Large	Good	Extraction	Long-Term Extraction Area
Large	Poor	Extraction	Short-term Extraction Area
Large	Good	Maintenance	Long-term Base Camp
Large	Poor	Maintenance	Short-term Base Camp
Small	Good	Extraction	Long-term Extraction Locus
Small	Poor	Extraction	Short-term Extraction Locus
Small	Good	Maintenance	Long-term Logistical Camp
Small	Poor	Maintenance	Short-term Logistical Camp

Step 2: Deriving least-cost movement ranges from base camps

Once the types listed above have been assigned to the sites in the project area, it is possible to create distance ranges, based on principles of least cost movement. In the past, site catchment analysis has approached this procedure by looking at either simple concentric rings of increasing radii around some center (based on Von Thunen's (1966) model), or by creating one or two hour "walks" (Roper 1979). The first method assumes the existence of an isotropic plain, a situation which obviously does not conform to the real world. The second attempts to consider the effects of topography when assigning a catchment, but is usually based on some ethnographically observed example, such as the !Kung. Perlman (1985), though, has already cautioned us about using this particular group too liberally as the basis for our analogies.

In contrast to these methods, the geographic information system approach creates distance rings of increasing radii from some center, as in the Von Thunen method; in addition, the method is able to consider topographic and hydrological features directly when distance is calculated. Instead of creating perfectly symmetrical distance rings, as would exist on an isotropic plain, the GIS method creates irregular distance rings, based on real world conditions.

To implement this method a hydrology overlay and a "terrain roughness" map overlay are required. The Hydrology layer (Map 2) was digitized from U.S.G.S. 1:100,000 quad sheets containing the project area. The "Rough" overlay was created by taking the second derivative of an Elevation map layer. Elevation (Map 3) was provided in digital format by the University of South Carolina Computer Services Division, and the Humanities and Social Sciences Computing Laboratory. The "differentiate" command in MapCgi allows the mathematical derivative of a map layer to be calculated. The first derivative of Elevation is change in elevation, or Slope (Map 4). The second derivative of Elevation (the first derivative of Slope) is change in Slope, or roughness of terrain. The "Rough" overlay (Map 5) is the result.

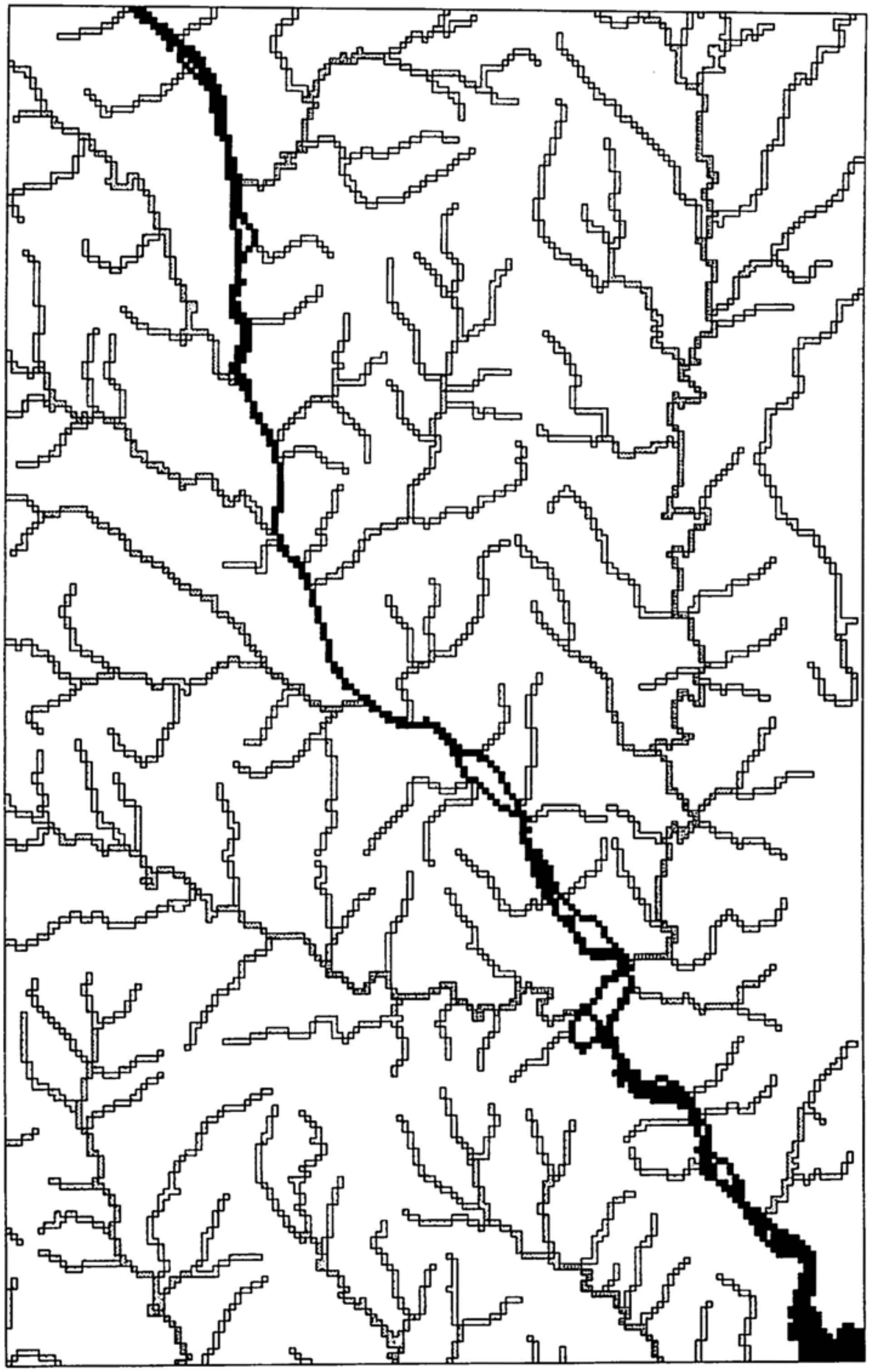
Once these two map overlays (Hydrology and Rough) are available, the distance from base camps may be determined in the Map Analysis Package with the "Spread" command. The base camp sites are isolated from the overall map of site types (Map 6), and distance is spread from them, over the "Rough" map and through the "Hydrology" map, to create the "Basecamp" map layer (Map 7). This overlay represents the cost of movement from known base camps across the physical landscape, expressed in terms of variable distances. Reference to Map 7 clearly shows the irregular nature of the distance rings spread from the base camp locations, reflecting the relative ease or difficulty of movement from various locations in the project area.

Step 3: Creating Thiessen polygons (habitual use areas)

Archaeologists have long used Thiessen polygons to divide space, and assign it to one group or another:

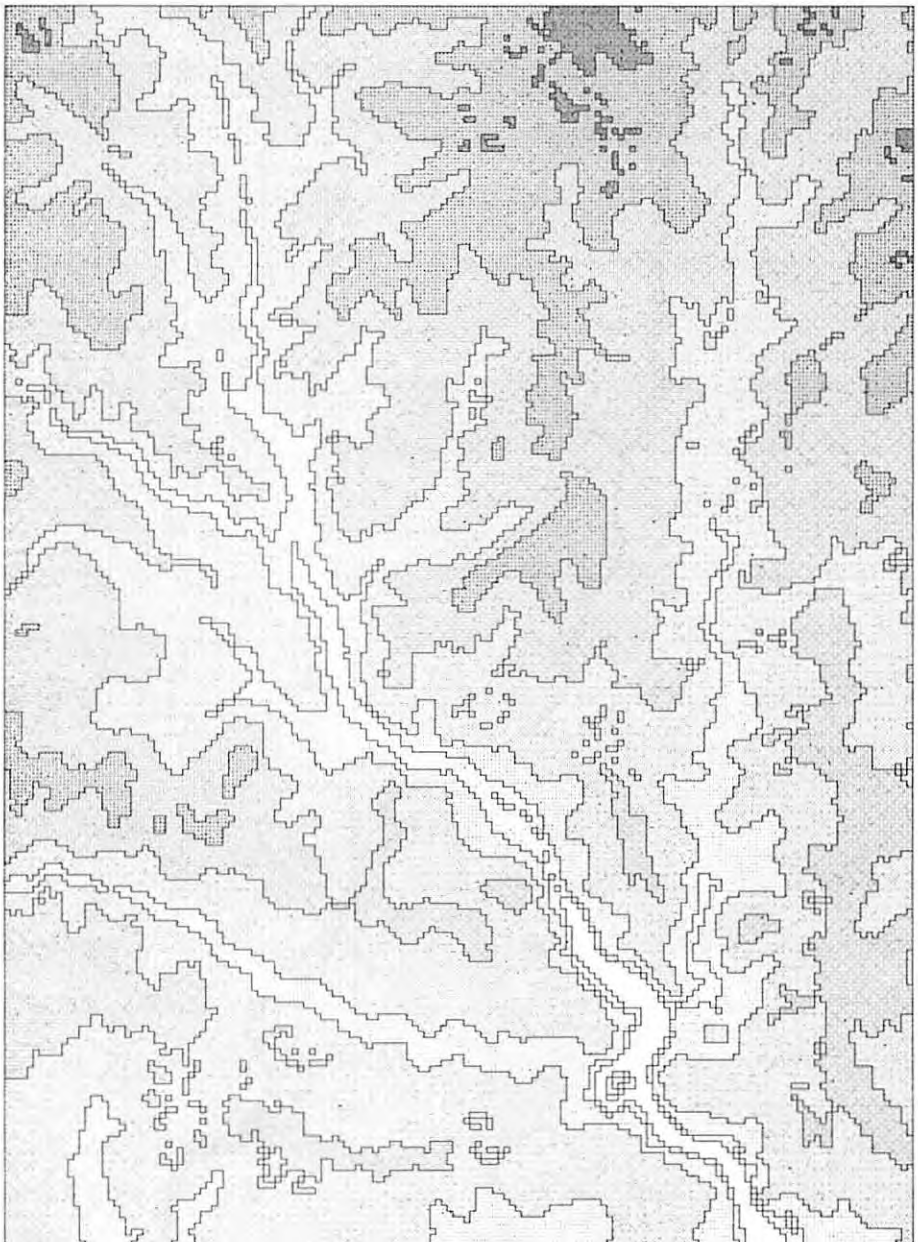
> How, then, have archaeologists set about reconstructing areas of landscape that fell under a single polity's [or group's] territorial jurisdiction [or habitual use] at specific times in the past? The simplest solution, in the absence of any explicit indications of political hierarchy, would be to contemplate a regional distribution of contemporaneous highest-order sites and partition the landscape in which they lie by drawing (weighted) Thiessen polygons around each of them [Cherry 1987:153].

The Thiessen polygon approach has been used by a number of archaeologists (Renfrew 1975; Cunliffe 1971; Hodder and Orton 1976).



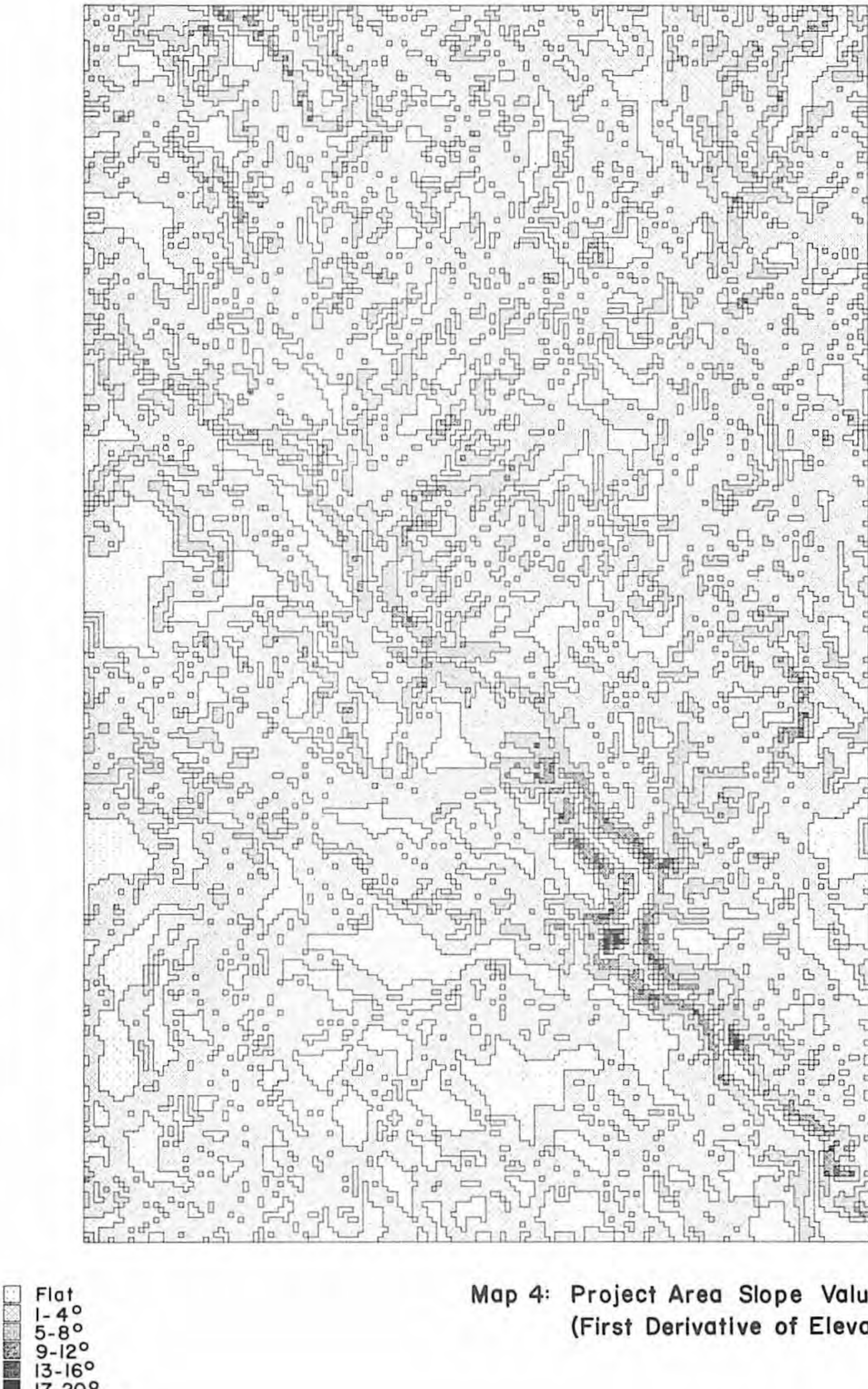
Rank 1 Streams
Rank 2 Streams
Rank 3 Streams
Savannah River

Map 2: Rivers and Streams in the Project Study Area.

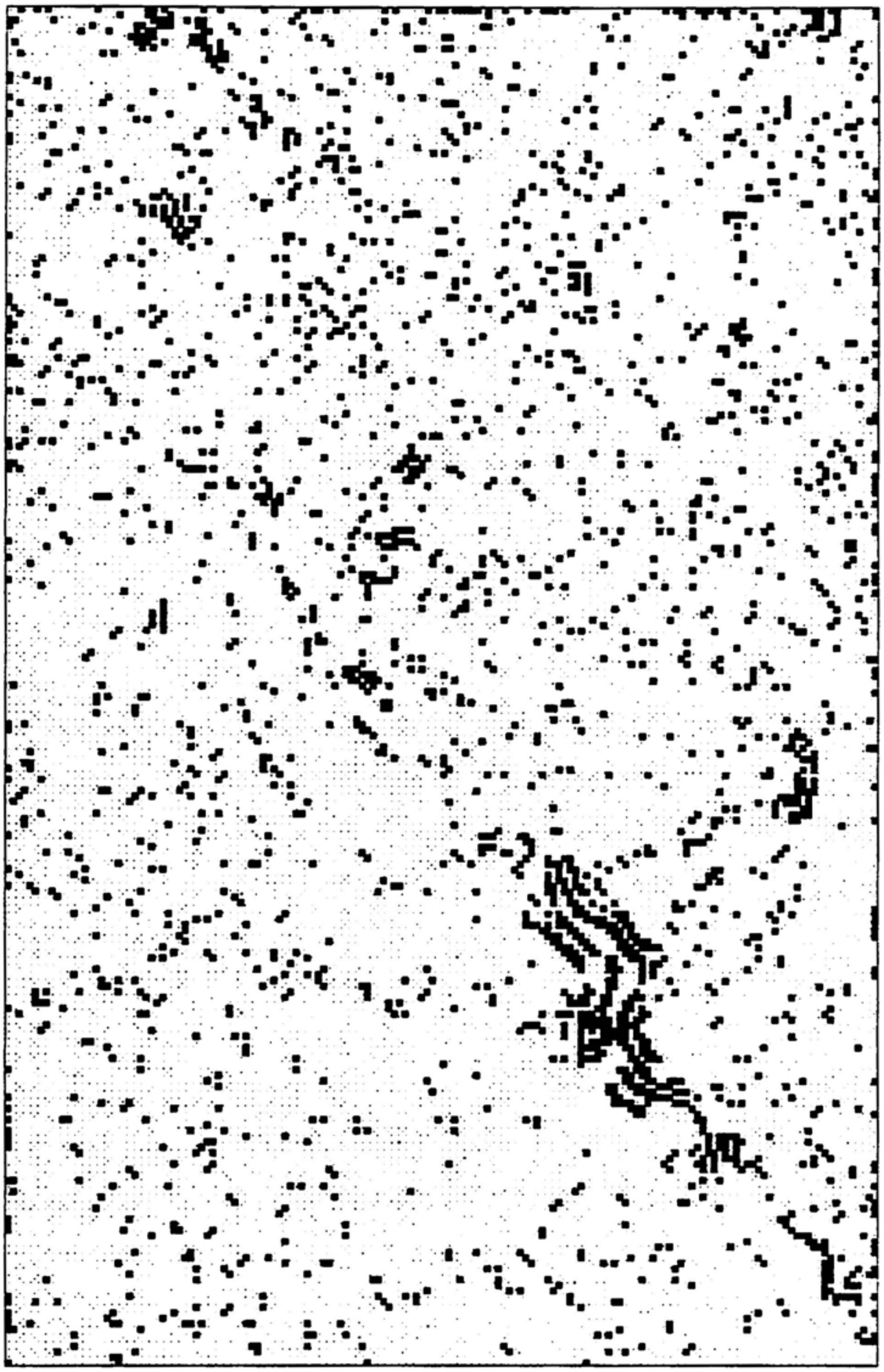


275 - 349'
350 - 424'
425 - 499'
500 - 574'
575 - 649'
650 - 724'
725 - 799'
Above M.S.L.

Map 3: Project Area Topography.

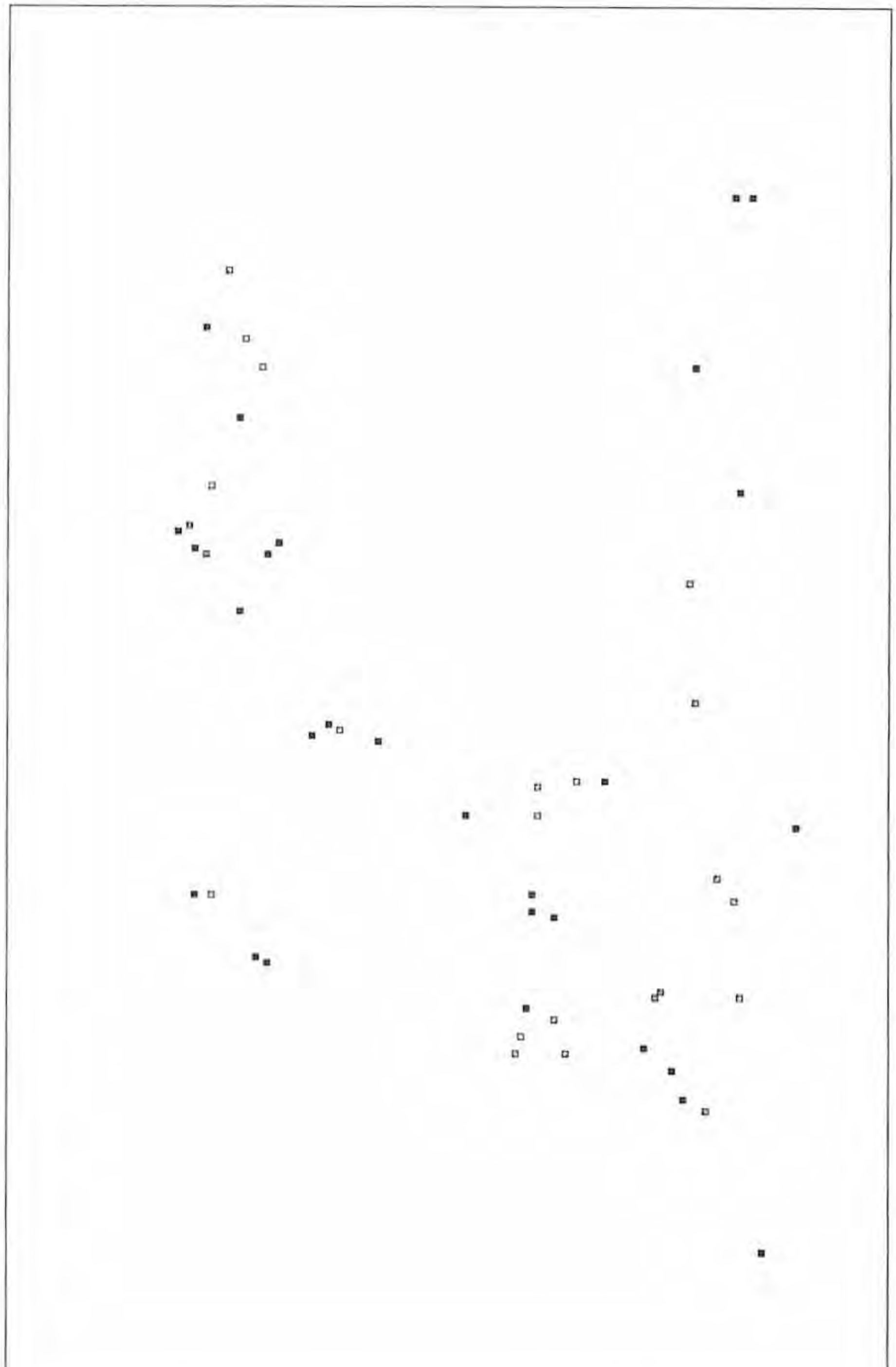


Map 4: Project Area Slope Values
(First Derivative of Elevation)



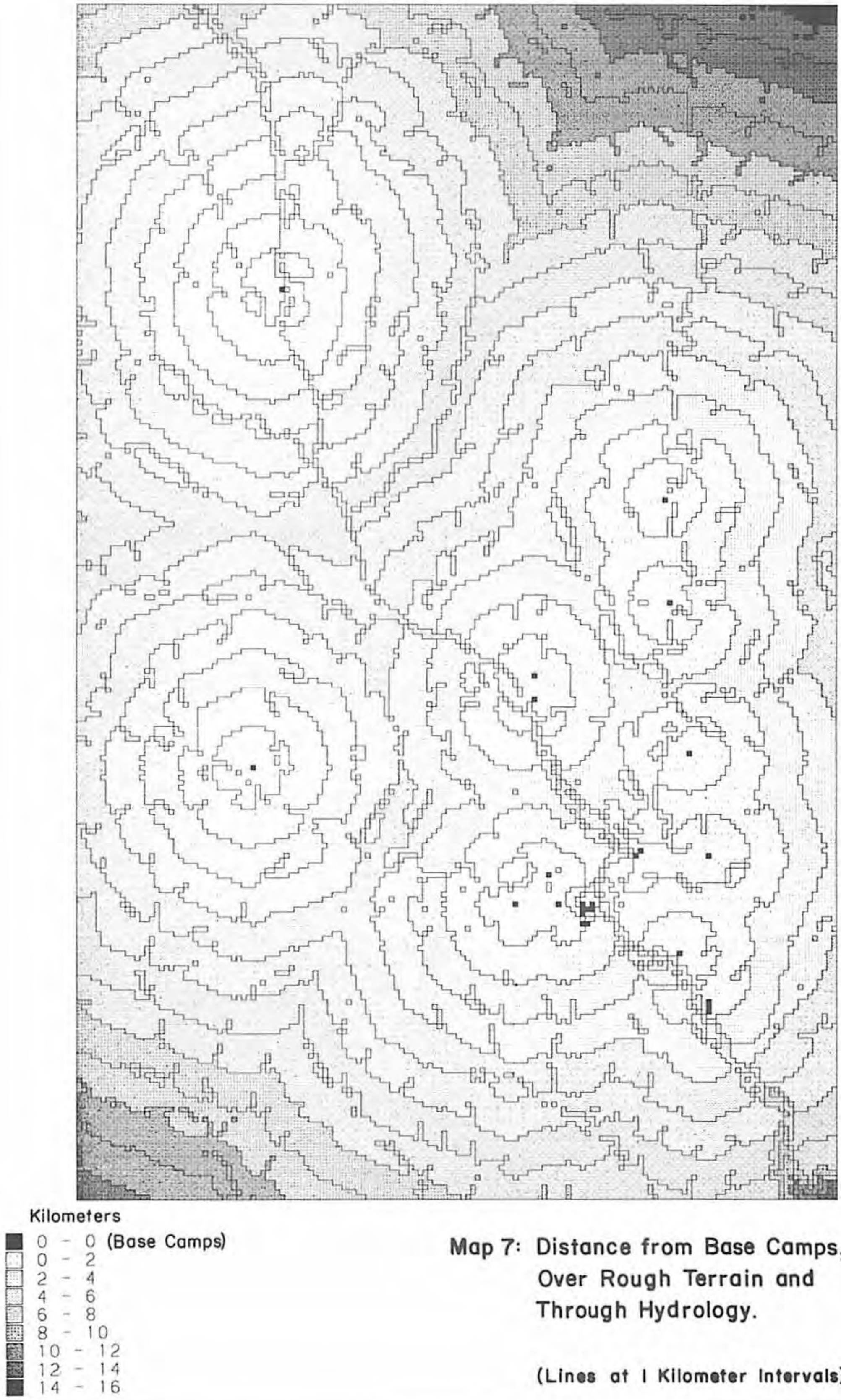
■ High Impedance
□ Low Impedance

Map 5: Terrain Roughness
(Movement Impedance — 2nd
Derivative of Elevation.)



Long-Term Extraction Area
Short-Term Extraction Area
Long-Term Base Camp
Short-Term Base Camp
Long-Term Extraction Locus
Short-Term Extraction Locus
Long-Term Logistical Camp
Short-Term Logistical Camp

Map 6: Site Types Based on Tool & Raw Material Variability, and Site Size.



Map 7: Distance from Base Camps, Over Rough Terrain and Through Hydrology.

(Lines at 1 Kilometer Intervals)

In the absence of evidence for a political hierarchy (for which none exists in the project area during the relatively still egalitarian Late Archaic), Cherry advocates drawing weighted polygons around each highest order site. In the Richard B. Russell project area, I would take the highest order sites to have been the base camps. Weighting has been accomplished by the consideration of least cost principles of movement over the physical landscape (Map 7). What remains, then, is to draw the lines of Thiessen polygons, and so identify the habitual use areas.

The Thiessen polygon boundaries (Map 8) were drawn in reference to the distances spread from base camp sites in the project area (Map 7). In practical terms, this was accomplished by dividing the landscape along straight lines which ran between areas of greatest equal distance between centers (base camps).

Exceptions to this rule were made when a number of base camps occurred in a very small area (within one to two kilometers of each other). In these cases, it was felt that what the site placement reflects is the use of an area as a base camp location, rather than a specific site. If the sizes of the sites are considered (on the maps only their center points are plotted), then some of the base camps become very close to each other. This situation may reflect different seasonal occupations by groups who essentially had a different idea of "site", or "place", than the archaeologists who recorded the remains.

The Thiessen polygons created thus reflect the existence of six different habitual use areas (Map 9) within the project area. Four had base camp locations situated within a relatively small area, while the other two are each represented by a single base camp location (Map 8).

Step 4: Overlaying site types on Thiessen polygons

The final step in assessing Test Implication #2 may be accomplished simply by overlaying a map of the different site types (Map 6) with Map 8, the Thiessen polygon boundaries, thus creating a map of site types within habitual use areas (Map 10). Since the boundaries of the Thiessen polygons were created without reference to any site types except the base camps required to create the distance measurements, the distribution reflected on Map 10 may be judged to be free from bias. Each habitual use area can be seen to contain a number of different site types, thus supporting Test Implication #2. (See Appendix A, Table 1 for a list of individual sites divided into different groups, or habitual use areas).

<u>Test Implication #3:</u> **The habitual use areas in the project area reflect the activities of minimum bands, rather than maximum bands.**

This test implication may be assessed by determining the size of each habitual use area, and multiplying it by an assumed population density figure. The population density has been assumed to range from .39 to 1.2 persons per square kilometer, based on data provided in Hassan (1981:Table 2.1) for acorn gatherer/hunter/fisher societies. The sizes of the various habitual use areas can be determined by describing Map 9 in the MapCgi system. The "Describe" command lists the number of grid cells assigned to all values in a map layer. Grid cells are 127 meters square, so the area in square kilometers may be obtained by multiplying the number of grid cells for each area by 16,129 (127 squared), and dividing by one million (one million square meters per square kilometer.) The results are as follows:

Table 2: Size of Habitual Use Areas in Square Kilometers

Group One	143.61 Km 2
Group Two	152.84 Km 2
Group Three	118.23 Km 2
Group Four	36.66 Km 2
Group Five	110.24 Km 2
Group Six	62.77 Km 2

Population estimates are then:

Table 3: Estimated Population Ranges of Habitual Use Areas

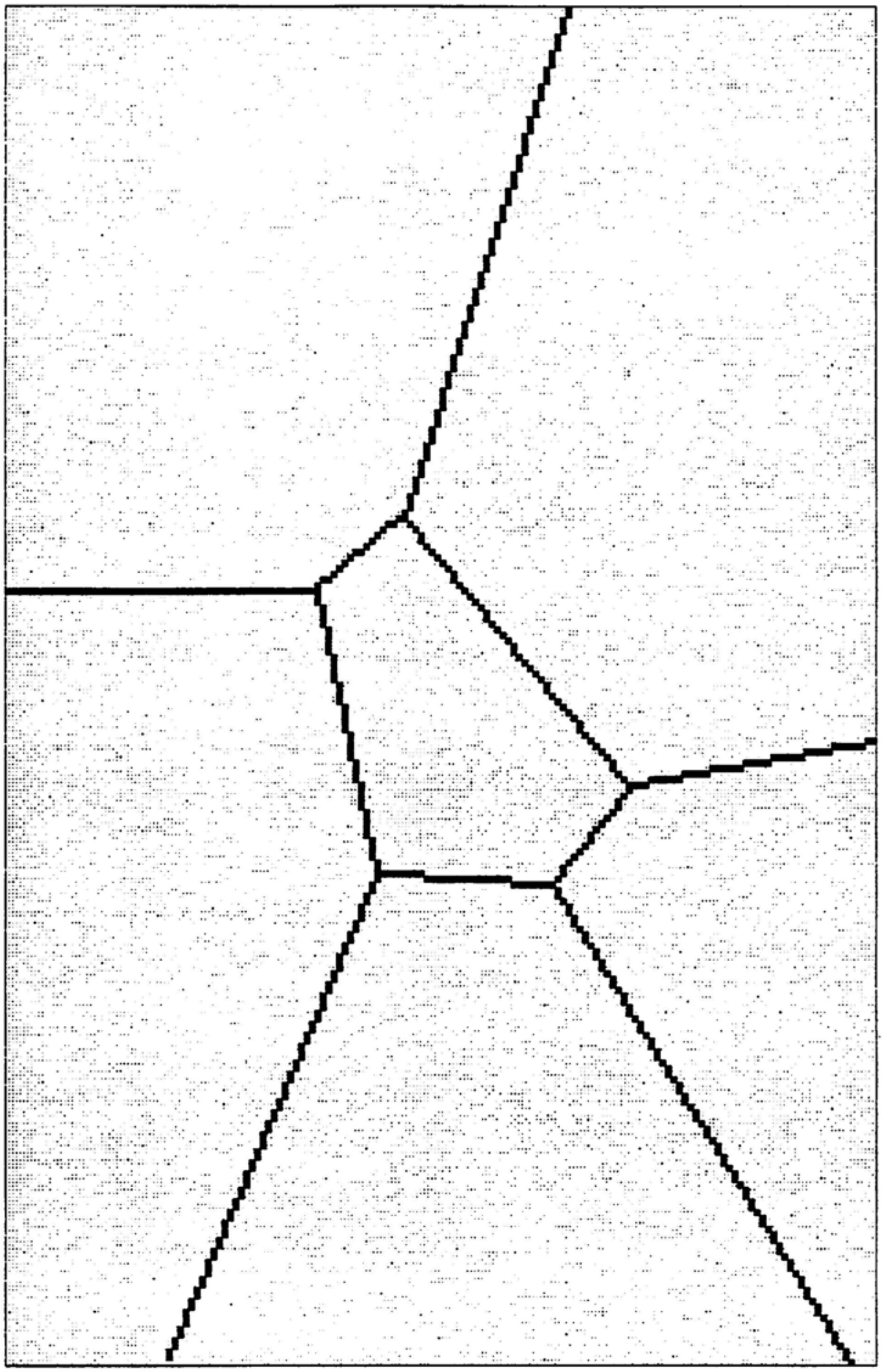
	Population Densities		
	.39	1.2	Average
Group One	56.0	172.3	114.2
Group Two	59.6	183.4	122.0
Group Three	46.1	141.9	94.0
Group Four	14.3	44.0	29.2
Group Five	43.0	132.3	87.7
Group Six	24.5	75.3	49.9
Total:	243.5	749.2	497.0

The average figures are well in line with the assumed population range of minimum bands of 20 to 120 people, suggesting that Test Implication #3 has been demonstrated. At the higher population density the habitual use areas would appear to support more than enough people for a minimum band; at the low density figure, the population in Group Four appears too low to have been a viable group.

The total figures for the low population density indicate that the project area contains one maximum band, assuming that those groups ranged from 200 to 600 people. At the higher population density, it would appear that the project area could support all of one, and part of another, maximum band. The average figure would also support one or two maximum bands, depending on the rules for acquiring mates in Late Archaic society.

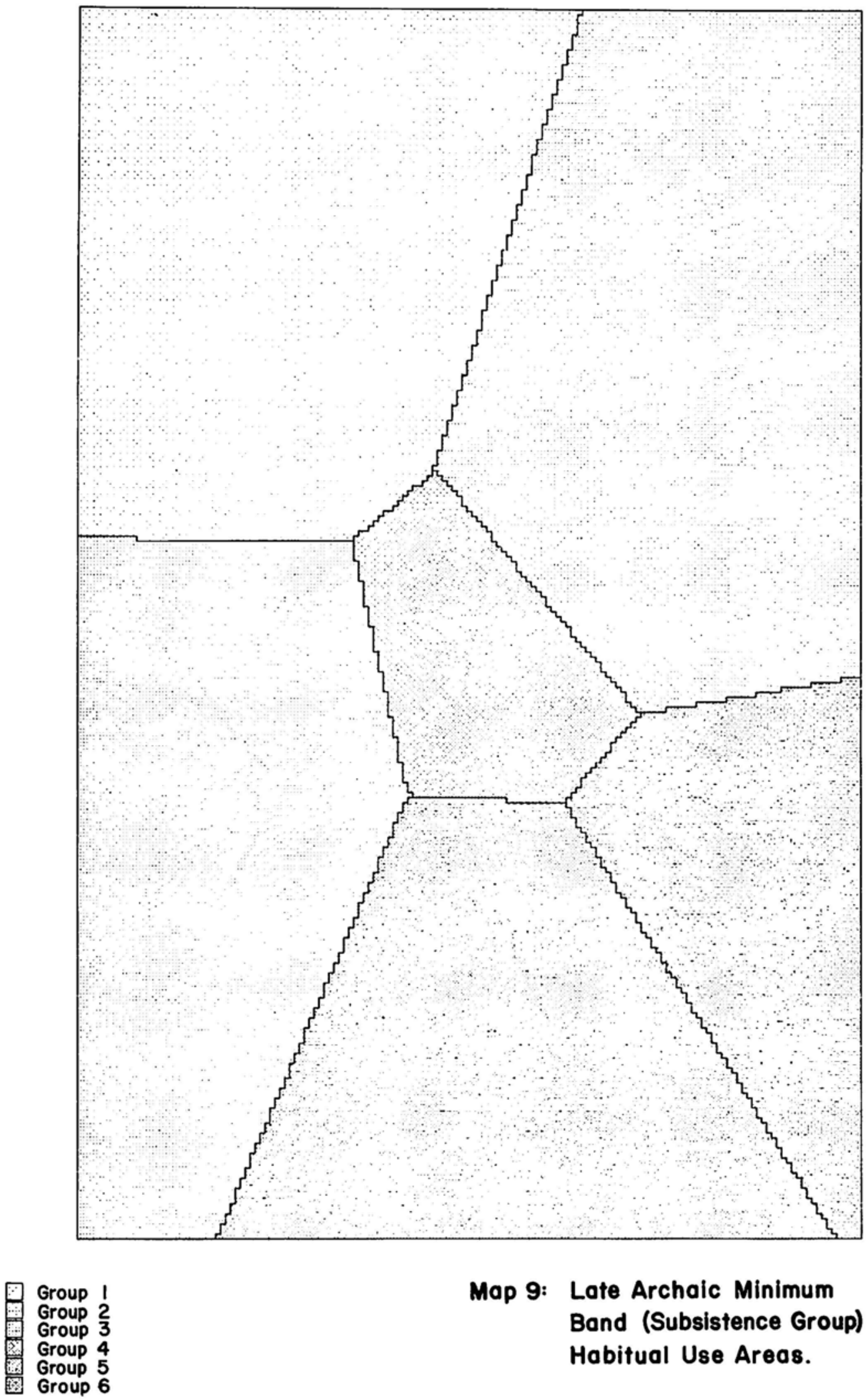
The size of the maximum band required to support a mating population depends on such things as incest rules, matrilocality versus patrilocality, and whether or not the system is open or closed (that is, whether or not people can look for mates outside of the maximum band) (Wobst 1974; Perlman 1985). Wobst's study of Paleolithic social groups assumed a minimum band size of 25, reflecting the "magic" ethnographic average for contemporary hunter/gatherer groups. The results indicated a maximum band size of 175 to 475 people (7 to 19 minimum bands) (1974:168).

This study has allowed both a larger minimum and maximum band size. Because of this allowance, fewer minimum bands are required to comprise a viable maximum band at the average population density assumed. At a high minimum band population, and a low requirement for composition of a maximum band, only two minimum bands are required to produce a viable maximum band. Conversely, with low minimum band sizes, and a high population requirement for a maximum band, nineteen or twenty minimum bands are required (as Wobst suggested). With average group sizes and population densities, though, the results of the population study tend to support Test Implication #3.

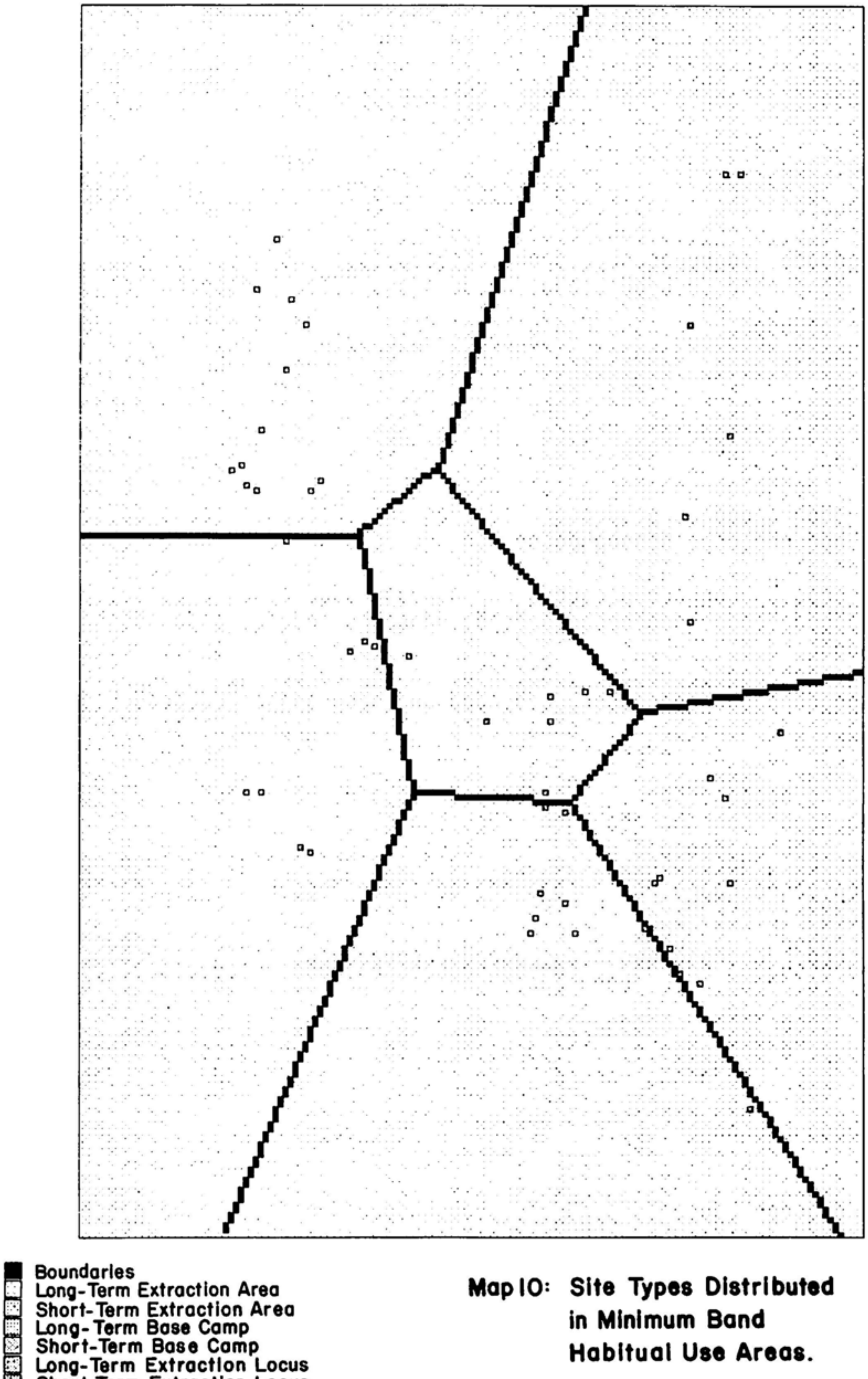


Polygon Boundaries
Project Area

Map 8: Thiessen Polygon Boundaries Based on Distance from Base Camps.



Map 9: Late Archaic Minimum Band (Subsistence Group) Habitual Use Areas.



Map 10: Site Types Distributed in Minimum Band Habitual Use Areas.

Test Implication #4: **The boundaries between habitual use areas will reflect uses both as edges and centers.**

Marquardt and Crumley's (1987) discussion of boundaries as edges and centers has been referenced above. In order to consider a boundary as a center there should be material evidence for some kind of interaction across the boundary. When no such evidence exists, the boundary may be considered to have functioned as an edge, adding a "whereness" to the understanding of boundary edges and centers.

In the Late Archaic there is evidence for long distance trade; Marquardt (1985) and Bender (1978) discuss the exchange of Great Lakes copper for Southeastern marine shells. Such trade would have cut across many minimum and maximum band areas, but the chances of its touching any given minimum band must be considered very low, given the apparent low volume of materials being exchanged. Interactions among minimum bands are more likely, it seems, to have been related to subsistence related exchange or cooperation. This notion seems all the more probable when we consider that a lot of people in any given minimum band were probably related to people in neighboring minimum bands. It should not surprise us to find evidence for cooperative hunting/gathering episodes among such groups of related people.

The evidence for this kind of interband cooperation across minimum band boundaries can, therefore, be expected to exist in the form of logistical camps and extractive areas near the boundaries between minimum bands.

I have noted above that the boundaries between habitual use areas were drawn without reference to any but the base camp sites in the project area. Keeping this in mind, two areas of potential cross boundary cooperation between minimum bands are shown in the project area (Map 11). This map overlay shows, in each of the small boxes, a long-term logistical camp, and one or more long-term extraction areas along the boundaries between minimum band habitual use areas. There is, in addition, a short-term extraction locus (a kill site) associated with each group.

I believe that these site groups demonstrate evidence for cooperative hunting/gathering between different minimum bands, and that the boundaries between the bands involved may be interpreted as centers for this intergroup cooperation at these places. Conversely, where no such site groupings exist, the boundary may be interpreted as an edge. This interpretation tends to support Test Implication #4.

Summarizing the Assessment of the General Test Implications

The General Test Implications were given as follows:

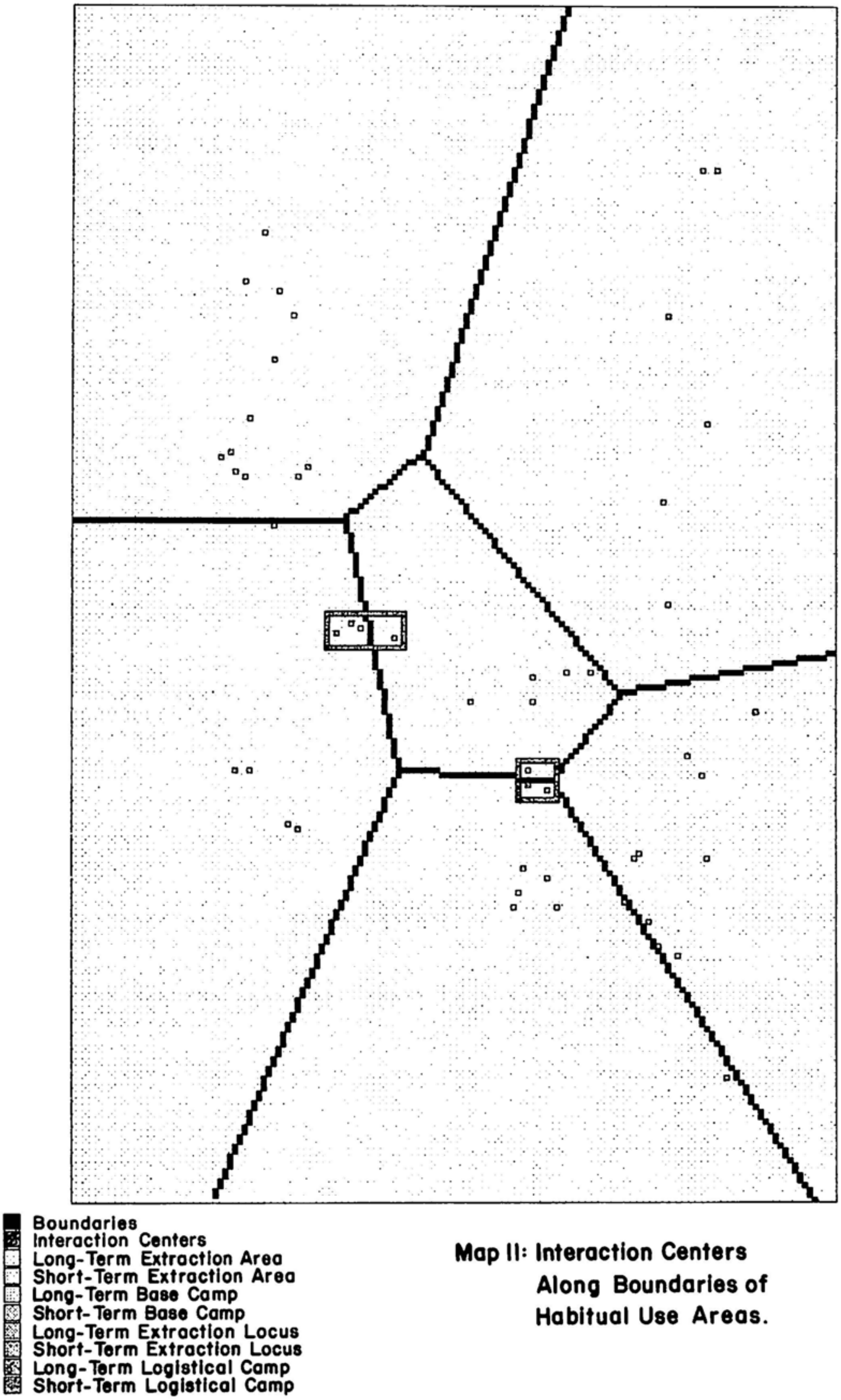
1. The distribution of Late Archaic sites in the project area is clustered, rather than random or regular.

2. A variety of site types, reflecting different temporal, spatial, and functional uses, will occur in each cluster.

3. The habitual use areas in the project area reflect the activities of minimum bands, rather than maximum bands.

4. The boundaries between habitual use areas will reflect uses both as edges and centers.

Test Implication #1 was demonstrated through the use of Nearest Neighbor Statistics. The sites are clustered within the project area.



Map II: Interaction Centers Along Boundaries of Habitual Use Areas.

The second Test Implication was demonstrated by creating a site typology based on the archaeological axes of space, time, and form; base camp sites were used to create spatial clusters, or habitual use areas, based on least cost principles of movement over rough terrain and through streams and rivers. Once Thiessen polygons had been created from the distance measurements, various site types were found to exist in each habitual use area, confirming the Test Implication.

The Test Implication that the project area reflects the activities of minimum bands, rather than maximum bands, was more tenuous because of the range of population possible within each area. Depending on whether the low, average, or high population density figures are chosen, the project area could contain more than one maximum band. In any case, though, the small sizes of the habitual use areas indicate that each was probably utilized by one minimum band.

The use of the boundary as a center is reflected in two groups of logistical camps and extraction areas associated with the boundary between different minimum band use areas. Other areas that do not present such site groups may be interpreted as edge places, rather than center places.

<u>Test Implication #5:</u> **Sites will be located along the stream and river system in the project area.**

This test implication has been developed primarily from the assumption that the spatial orientation of habitual use areas will conform to known patterns of land use. The Southeastern Late Archaic has been characterized as "river system extensive" by Taylor and Smith: "The distribution of Late Archaic sites from the coast of South Carolina and Georgia up the Savannah River and into the Appalachian Summit area suggests that it was at this time that human adaptations were river system extensive" (1978:323).

As I have noted in Chapter II, their work reaffirms the connection between the early riverine models and the settlement in the Russell Reservoir. House and Ballenger (1976) also stress a riverine adaptation, though with some seasonal movement into the uplands:

> Based on the present data we propose a settlement pattern model for the Middle and Late Archaic involving spring and summer residence along major rivers; a move to seasonal base camps in upland creek valleys in September to take advantage of deer concentration in the upland hardwood zones, with some exploitation of other resources as well; and then a return to riverine-located winter quarters . . . [1976:117].

Taylor and Smith's analysis of the sites in the Russell Reservoir centered on nominal topographic landform types such as "ridge nose", "terrace", "bluff", and the like. Based on this designation, they calculated a ratio of lowland to upland sites for Early, Middle, and Late Archaic (1978:Table 66). The ratio for Early Archaic was .21, for Middle Archaic it was .31, and for the Late Archaic, the ratio was .59. Nearly twice as many Late Archaic sites in the project area fall within lowland zones than in the Middle Archaic, and nearly three times as many as in the Early Archaic. (Lowland zones contained terrace, levee, bottomland knoll, river, bluff and island landforms. Upland landforms included ridge nose, ridge slope, ridge top, saddle, and upland knoll categories.) Using the Map Analysis Package GIS, and the MapUtil program written for this analysis (Appendix C: <u>MapUtil.Bas--The MapAnalysis Package External Utilities Program</u>), the actual distances from all Late Archaic sites to the nearest water source (Table 4) was measured:

Table 4: Distribution of the Distance to Nearest Water Variable

Distance	Count	Percentages Cell	Percentages Cumulative
0 m	2	3.9	3.9
127 m	22	43.1	47.1
254 m	7	13.7	60.8
381 m	9	17.6	78.4
508 m	2	3.9	82.4
635 m	4	7.8	90.2
762 m	3	5.9	96.1
889 m	2	3.9	100.0

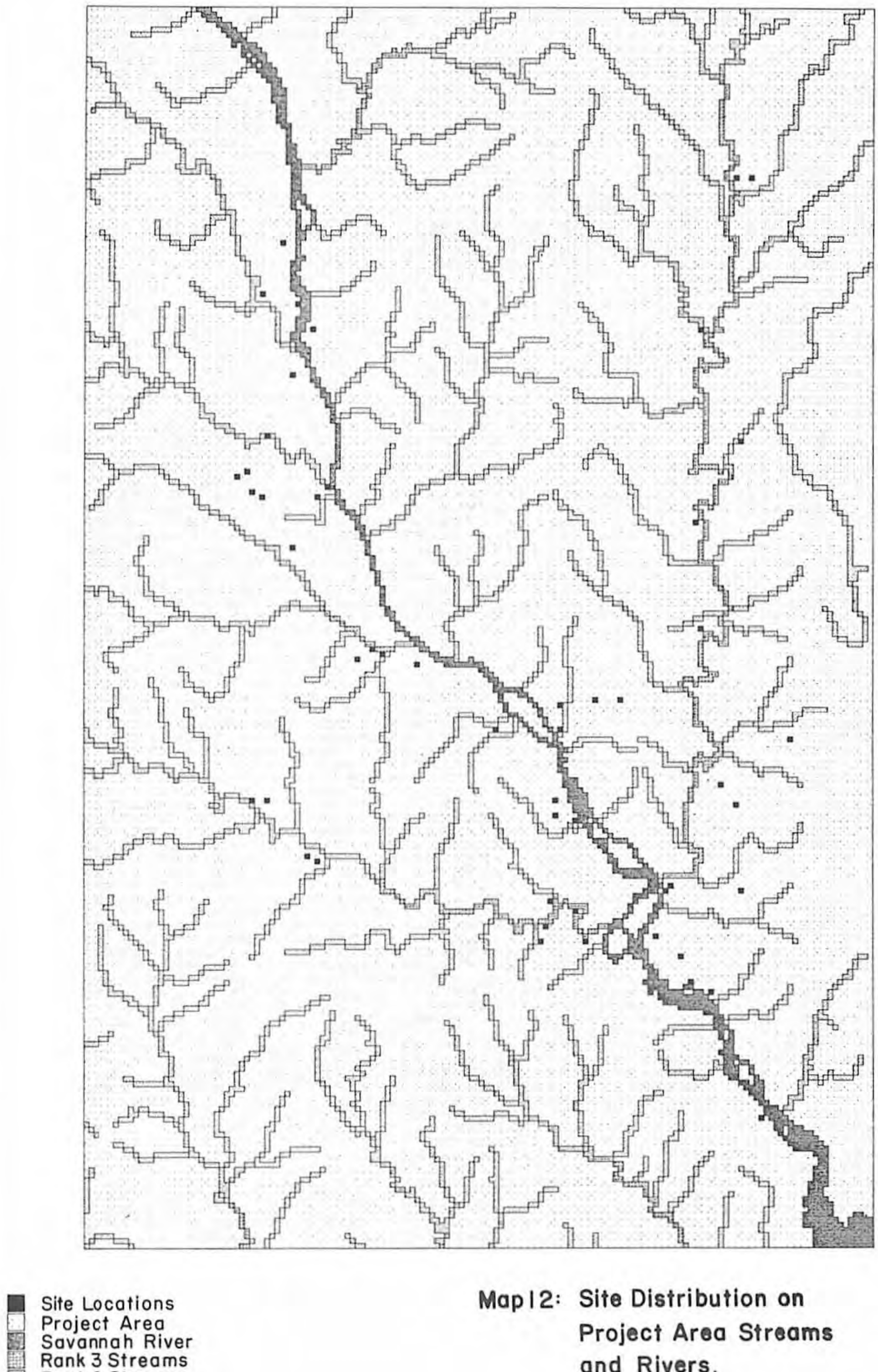
Over sixty percent of the sites are located within 254 meters of the nearest water. A map of the sites and project area hydrology (Map 12), and a frequency bar chart showing this relationship are presented below. See Appendix D: Additional Site Data for individual distances.

FREQUENCY BAR CHART

```
FREQUENCY

   |       *****
   |       *****
20 +       *****
   |       *****
   |       *****
   |       *****
   |       *****
15 +       *****
   |       *****
   |       *****
   |       *****
   |       *****
10 +       *****
   |       *****       *****
   |       *****       *****
   |       ***** ***** *****
   |       ***** ***** *****
 5 +       ***** ***** *****
   |       ***** ***** *****       *****
   |       ***** ***** *****       ***** *****
   | ***** ***** ***** ***** ***** ***** ***** *****
   | ***** ***** ***** ***** ***** ***** ***** *****
   +------------------------------------------------
       0    127   254   381   508   635   762   889
```

H2ODIS (Distance to Nearest Water)



Map 12: Site Distribution on Project Area Streams and Rivers.

These three lines of evidence, the summary presented in Taylor and Smith (1978), the results of the frequency distribution on distance to closest water source, and the map of project area sites and hydrology, demonstrate the validity of Test Implication #5.

Test Implication #6: **Habitual use areas will straddle the major drainages in the project area, and will be bounded by other topographic features such as ridgetops or minor drainages.**

The first part of this test implication, that the habitual use areas will straddle the major drainages in the project area, can be demonstrated by inspecting Map 13, which shows the Thiessen polygons overlaid on the project area hydrology. Note that in all the polygons the Savannah River, or one of its rank three tributaries, cuts through the polygon. In the lower left polygon, while only a short portion of a rank three stream runs through the area, there are several long rank two streams. In the lower right corner of the project area, two polygons are bounded by the Savannah River. Referring back to the BaseCamp and "Rough" overlays (Maps 7 and 6), it may be seen that in this case the terrain is extremely rough in this area, thus prompting its use as a boundary here. There are, though, portions of three rank three streams in one area, and one in the other. This part of the Test Implication is demonstrated by Map 13.

The second part of the Test Implication may be assessed by reference to two overlays (Maps 13 and 14), and by two Chi-square tests.

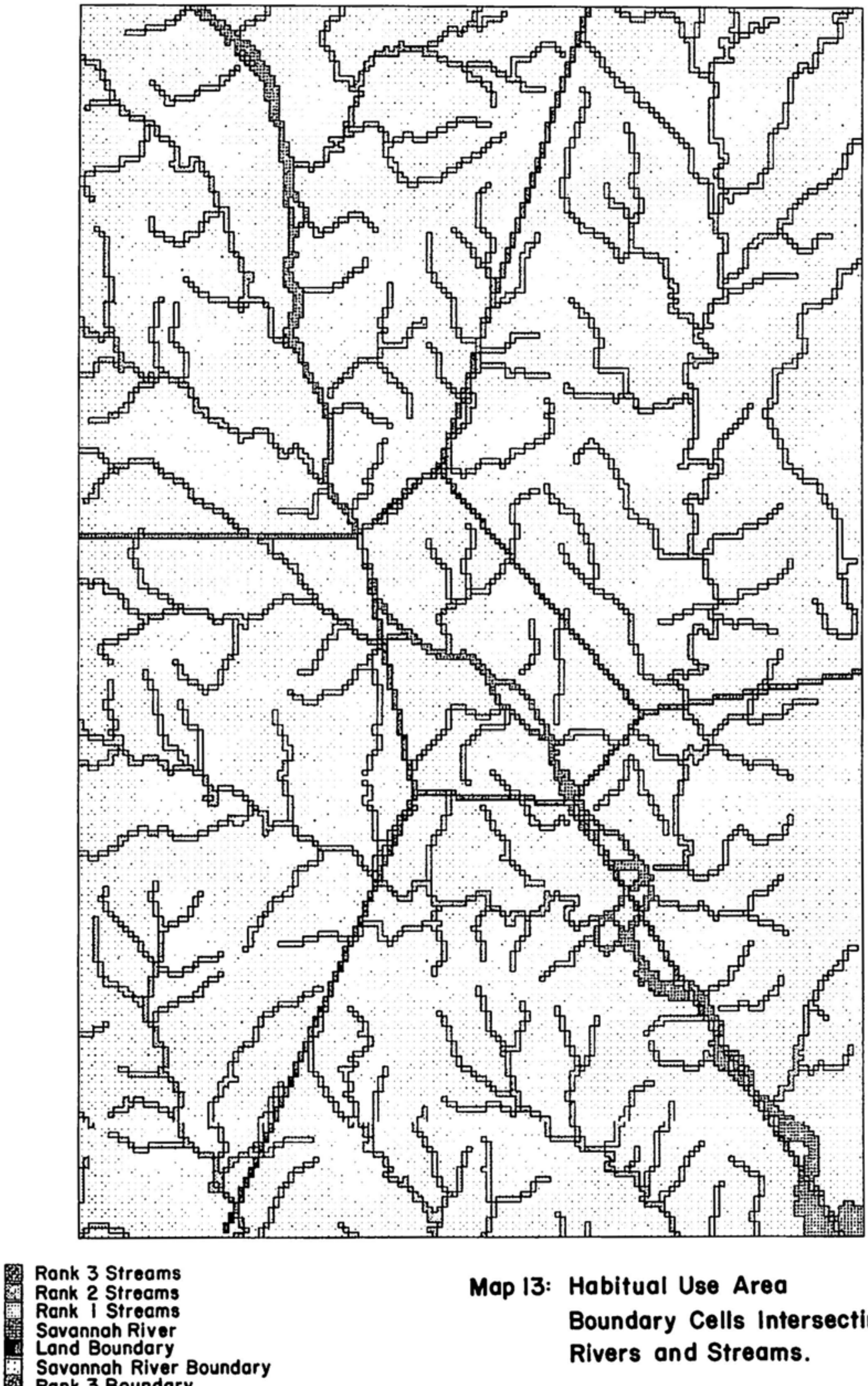
Map 14 presents an intersection of the Thiessen polygon boundary cells with the cells in the project area which have ridgetop profiles (this overlay was created with the MapCgi Profile command, looking in eight compass directions). The map indicates places where the boundary crosses ridgetops. The results of the Chi-square test (Appendix A:Table 6) on the cell count recovered from MapCgi indicate that ridgetop cells are not significantly associated with boundary cells (Chi-square = .342, p = .559).

The intersection of polygon boundary cells with project area hydrology is shown on Map 13. In this case, Chi-square tests (Appendix A:Table 7) indicate a strong association between the two (Chi-square = 384.434, p = .000). Examination of the cell Chi-square values shows that the overwhelming contribution to this high figure is by the boundary at the Savannah River in the lower right of the project area.

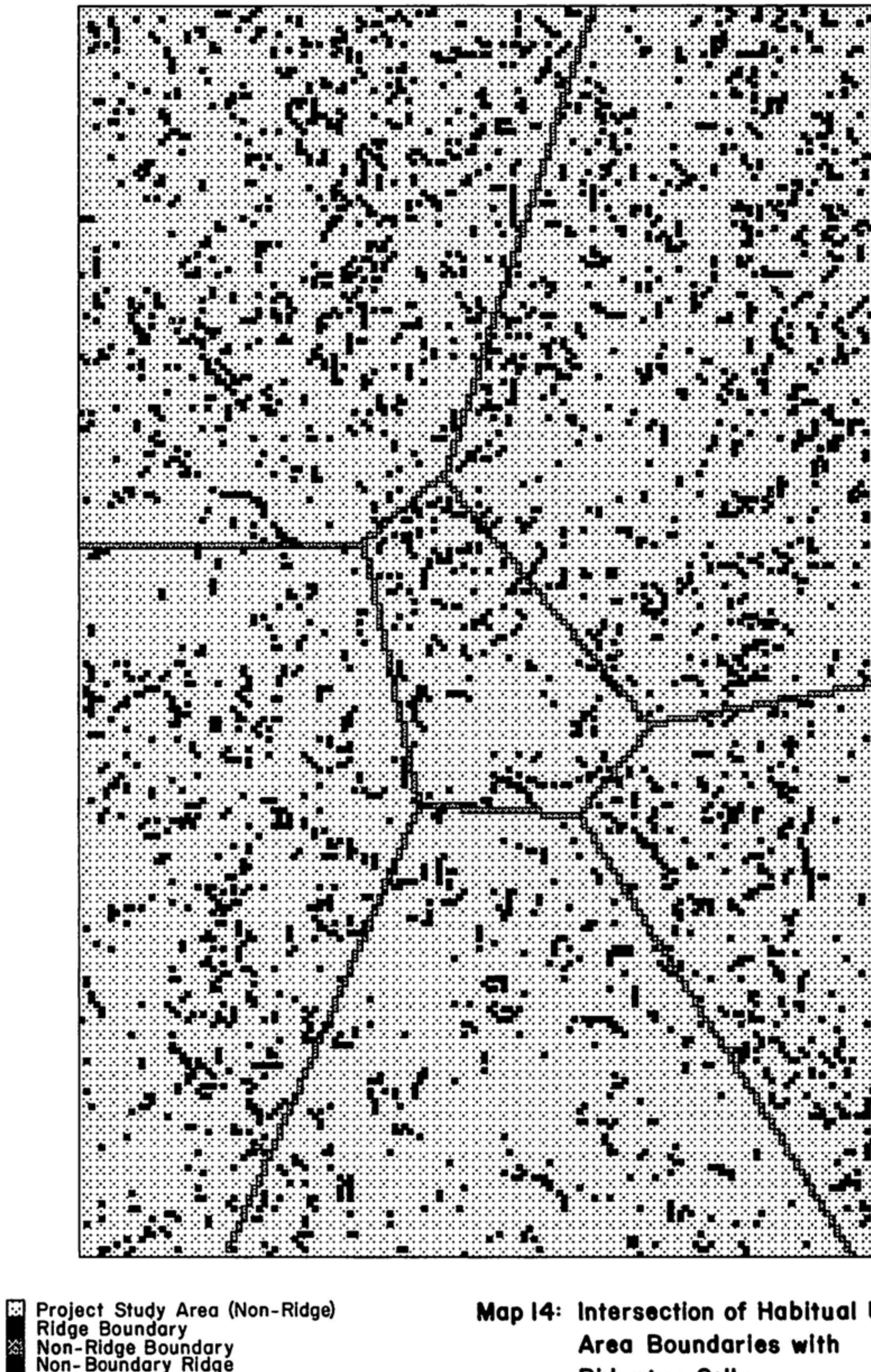
Because the Savannah River is clearly visible on the BaseCamp overlay (Map 6), and this overlay was used to draw the polygon boundaries, I felt that inclusion of the Savannah River cells in this test might have biased the result, since I consciously drew the polygon boundary down the line of the river. For this reason, another Chi-square test (Appendix A:Table 8) was run, without the Savannah River cells. The results are again indicative of a strong association between hydrology and polygon boundaries (Chi-square = 42.243, p = .000). Since I was not sure of the location of any streams in the project area except the Savannah River when I drew the polygon boundaries, this test is less biased, but still confirms Test Implication #5.

Summarizing the Assessment of the Specific Test Implications

Reference to Taylor and Smith (1978), and the direct measurements of distance to nearest water, suggest that the Late Archaic sites in the project area are oriented to the river system, thus demonstrating Test Implication #5. The assessment of Test Implication #6 indicates that the habitual use areas in the project area tend to be bounded by hydrology features rather than ridgetops.



Map 13: Habitual Use Area Boundary Cells Intersecting Rivers and Streams.



Map 14: Intersection of Habitual Use Area Boundaries with Ridgetop Cells.

Both of these results stress the overall riverine orientation of Late Archaic peoples, as noted by Taylor and Smith (1978), House and Ballenger (1976), and Goodyear, House and Ackerly (1979). What is surprising is the boundary emphasis on hydrological features rather than other topographic features such as ridgetops. The riverine environment appears to have been of such importance to Late Archaic societies that these features formed not only the centers of habitual use areas, but the edges of them as well. For a riverine oriented society, the most prominent features of the landscape are the rivers and streams, not the ridgetops separating them.

SUMMARY: IS THE HYPOTHESIS DEMONSTRABLE?

The six test implications derived from the hypothesis and bridging arguments have been demonstrated, therefore lending credibility to the overall hypothesis that **The Late Archaic Social Landscape consisted of Maximum Band Social Territories, divided into Minimum Band Subsistence Territories.** This analysis has produced six habitual use areas within the project area, ranging in size from 36.66 to 152.84 square kilometers. Based on a population density ranging from .39 to 1.2 persons per square kilometer, the landscape in the project area would have supported between 245 and 749 people, averaging at 497, well within the range of one maximum band. Thus, the project area appears to have supported six minimum bands, associated in one maximum band.

CHAPTER VI

CONCLUSION: THEORY AND METHOD IN LANDSCAPE ARCHAEOLOGY

THEORY: LANDSCAPE ARCHAEOLOGY

The concept of Landscape Archaeology unites many of the traditional approaches to archaeological research. In particular, this thesis has demonstrated how such traditionally divergent themes as Geographic Location Theory, models of social organization, boundary studies, site function, demographics, and subsistence models may be shown to converge on questions examined under a broad theoretical perspective illuminated by Landscape Archaeology.

I have noted in Chapter II that the issues that make the Late Archaic period exciting are the social changes that accompany the period. By using the Landscape Archaeology paradigm it has been possible to go beyond subsistence-related studies, to get at these social issues. By recognizing the roles of the cognitive environment in both physical and cultural terms, I have been able to utilize such constructs as Pred's Geographic Location Theory to take an actor-centered approach to the past. A dynamic understanding of the past is created, one that allows conflict and resolution, control and manipulation of information, and the various abilities of the actors involved to actively change their world. Landscape Archaeology is able to put people back at the center of research by emphasizing the nature of human interaction in the physical, cultural, and cognized realms that together comprise past cultural systems.

METHOD: GEOGRAPHIC INFORMATION SYSTEMS

The advent of Geographic Information Systems has allowed archaeologists to apply the integrative approach of Landscape Archaeology by providing a means to study all the dimensions of form across space in ways that produce outputs at once easy to interpret and aesthetically pleasing. Because all data processed in a GIS is forced to be spatially referenced, the locational information is not lost when archaeologists analyze form and time. Berry's (1964) description of the world as locations that possess attributes in time can be directly translated into the archaeologist's axes of space, form, and time. For the first time, all three archaeological dimensions may be analyzed together.

GIS presents a powerful methodological solution to the archaeologist's dilemma of dealing with three-dimensional data. Many times in the past, avant-garde techniques have been introduced to archaeologists, only later to be shown as essentially an "electrocution of artifacts" that produced no real contribution other than fancy-looking analyses and reports. Geographic Information Systems, though, present a methodology that can make substantial contributions to the development of anthropological theory, as well as provide general purpose data management, analysis, and display. Data can be analyzed in ways impossible before the advent of GIS. Different, spatially referenced, data themes may be developed, representing different times, artifact distributions, settlement patterns, or the like. These themes can be analyzed synchronically and diachronically in ways that contribute directly to the development and testing of anthropological theory. Many times during the development of this project anthropological theory and GIS methods were evaluated against each other, to the improvement of the final product. A truly effective combination of theory and method has been demonstrated in this thesis as a result.

RESULTS OF THIS STUDY

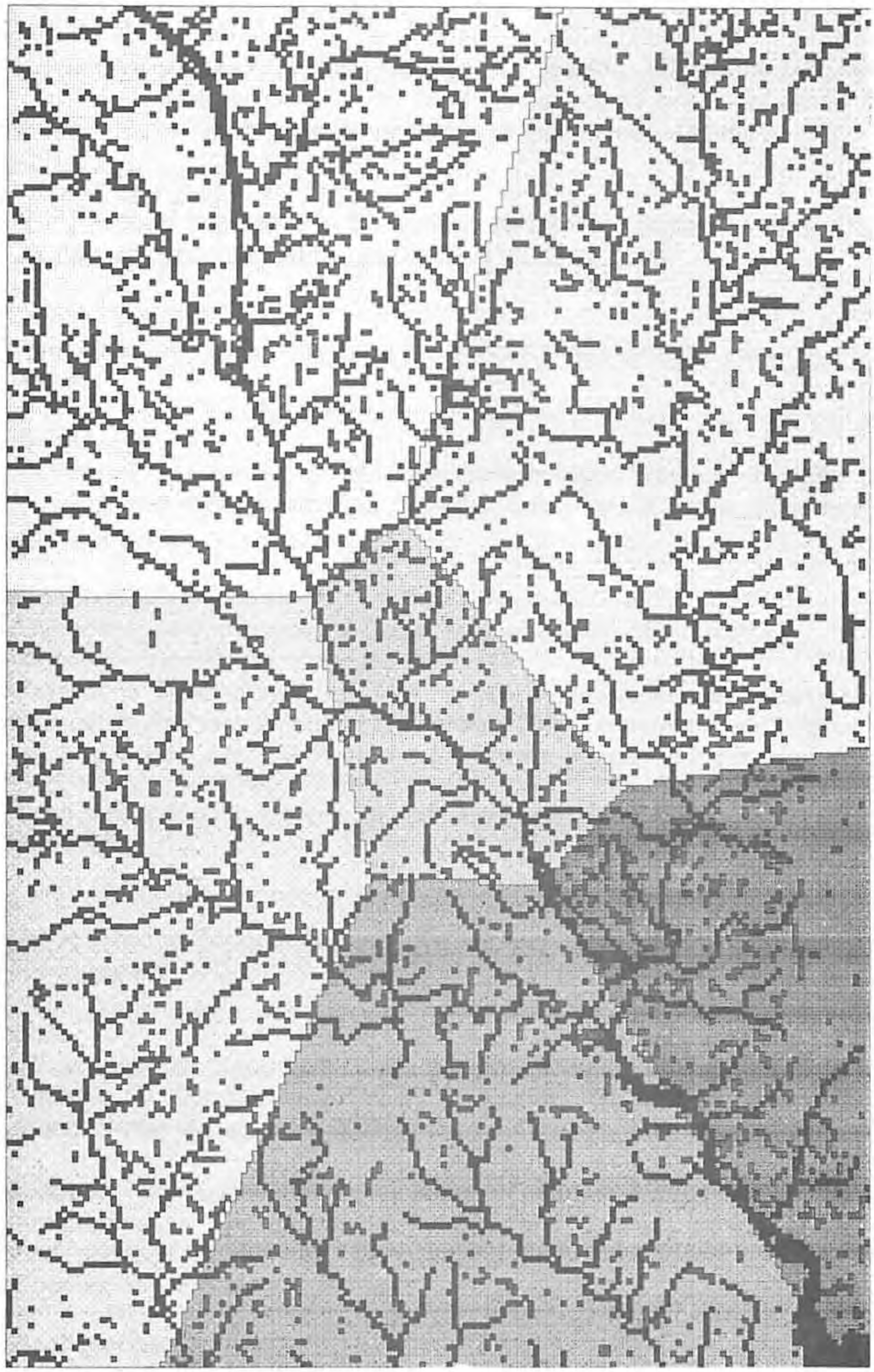
This work offers a model of Late Archaic social organization that considers many aspects of the physical, cultural, and cognized landscapes (Map 15). Based on principles of least cost, six minimum band habitual use areas (social territories) have been assigned that consider the effects of movement and communication over the physical landscape. Different minimum bands have been shown to occupy separate habitual use areas within the project study area. As illustrated on Map 11, it is possible to understand within-and between-group interaction in light of issues related to boundary centers and edges. By analyzing the sizes of various use areas, population estimates have been developed for each.

POSSIBILITIES FOR FUTURE WORK

With these beginnings, other questions may be asked, questions relating to inter- and intra-group dynamics, as some minimum band groups demonstrate greater successes in exploiting their surroundings, and greater reproductive success. We might expect minimum band group boundaries to shift over time in ways that reflect the various successes and failures of the maximum band's constituent groups--as one group expands and another contracts. Inter-group cooperation and conflict may be examined in response to physical and social environmental perturbations.

Issues of this sort may be examined at the larger, maximum band level as well. There is evidence for increasing hostility in the Late Archaic. It seems possible, given the minimum/maximum band model demonstrated here, that such hostility may have existed primarily between maximum bands, where fewer personal interrelationships are likely to have existed than in a single maximum band's constituents.

Another avenue of research in this area would take advantage of the ability of the GIS to model long-term cultural processes. By conducting a similar study with Middle Archaic sites in the Russell Reservoir, a diachronic perspective of changing social organization may be achieved. It will be possible to explain the complex technological and subsistence changes observed between these two periods in terms of social dynamics, rather than just changing point types and new food resources. The combination of Landscape Archaeology and Geographic Information Systems, therefore, offers a truly new way of looking at old things.



Map 15: The Late Archaic Social Landscape in the Savannah River Valley.

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APPENDIX A: PROJECT TABLES

Table 1: Project Area Site Groups

GROUP ONE

SITE	SIZE	IVAR	IMAT	SIZGRP	IVARGRP	IMATGRP	SITEUSE
38AN005	10000	0.56	0.67	Large	Extraction	Good	L/T Extraction Area
09EB276	40000	0.56	0.33	Large	Extraction	Poor	S/T Extraction Area
09EB395	40000	0.56	0.33	Large	Extraction	Poor	S/T Extraction Area
09EB261	18000	0.67	0.50	Large	Maintenance	Good	L/T Base Camp
09EB283	2250	0.44	0.67	Small	Extraction	Good	L/T Extraction Locus
09EB286	1500	0.56	0.50	Small	Extraction	Good	L/T Extraction Locus
09EB300	7500	0.56	0.33	Small	Extraction	Poor	S/T Extraction Locus
09EB418	5625	0.56	0.17	Small	Extraction	Poor	S/T Extraction Locus
09EB291	2500	0.56	0.17	Small	Extraction	Poor	S/T Extraction Locus
09EB281	1250	0.44	0.33	Small	Extraction	Poor	S/T Extraction Locus
09EB285	7425	0.67	0.50	Small	Maintenance	Good	L/T Logistical Camp
09EB388	1800	0.78	0.50	Small	Maintenance	Good	L/T Logistical Camp

GROUP TWO

SITE	SIZE	IVAR	IMAT	SIZGRP	IVARGRP	IMATGRP	SITEUSE
38AB089	26000	0.89	0.50	Large	Maintenance	Good	L/T Base Camp
38AB114	13000	0.78	0.50	Large	Maintenance	Good	L/T Base Camp
38AB119	7500	0.44	0.33	Small	Extraction	Poor	S/T Extraction Locus
38AB133	500	0.33	0.33	Small	Extraction	Poor	S/T Extraction Locus
38AB136	2500	0.67	0.50	Small	Maintenance	Good	L/T Logistical Camp
38AB274	400	0.78	0.67	Small	Maintenance	Good	L/T Logistical Camp

GROUP THREE

SITE	SIZE	IVAR	IMAT	SIZGRP	IVARGRP	IMATGRP	SITEUSE
09EB366	10000	0.44	0.50	Large	Extraction	Good	L/T Extraction Area
09EB058	30000	0.78	0.17	Large	Maintenance	Poor	S/T Base Camp
09EB063	2400	0.56	0.17	Small	Extraction	Poor	S/T Extraction Locus
09EB315	1200	0.44	0.33	Small	Extraction	Poor	S/T Extraction Locus
09EB328	4200	1.00	1.00	Small	Maintenance	Good	L/T Logistical Camp
09EB056	3700	0.67	0.67	Small	Maintenance	Good	L/T Logistical Camp
09EB057	5000	0.78	0.17	Small	Maintenance	Poor	S/T Logistical Camp
09EB327	1875	0.67	0.17	Small	Maintenance	Poor	S/T Logistical Camp

Table 1: Project Area Site Groups, continued

GROUP FOUR

SITE	SIZE	IVAR	IMAT	SIZGRP	IVARGRP	IMATGRP	SITEUSE
38AB239	30000	0.56	0.33	Large	Extraction	Poor	S/T Extraction Area
38AB077	100000	0.78	0.83	Large	Maintenance	Good	L/T Base Camp
38AB288	9000	0.89	0.67	Large	Maintenance	Good	L/T Base Camp
38AB078	5250	0.33	0.17	Small	Extraction	Poor	S/T Extraction Locus
09EB320	3000	0.56	0.17	Small	Extraction	Poor	S/T Extraction Locus
09EB340	1875	0.33	0.17	Small	Extraction	Poor	S/T Extraction Locus
09EB351	3000	0.67	0.50	Small	Maintenance	Good	L/T Logistical Camp

GROUP FIVE

SITE	SIZE	IVAR	IMAT	SIZGRP	IVARGRP	IMATGRP	SITEUSE
09EB219	11250	0.56	0.50	Large	Extraction	Good	L/T Extraction Area
09EB092	140000	0.89	0.83	Large	Maintenance	Good	L/T Base Camp
09EB218	76500	0.78	1.00	Large	Maintenance	Good	L/T Base Camp
09EB208	45000	1.00	1.00	Large	Maintenance	Good	L/T Base Camp
09EB076	7500	0.78	0.83	Small	Maintenance	Good	L/T Logistical Camp
09EB204	1800	0.67	0.50	Small	Maintenance	Good	L/T Logistical Camp
09EB255	1000	0.67	0.50	Small	Maintenance	Good	L/T Logistical Camp
09EB405	7500	0.67	0.33	Small	Maintenance	Poor	S/T Logistical Camp

GROUP SIX

SITE	SIZE	IVAR	IMAT	SIZGRP	IVARGRP	IMATGRP	SITEUSE
38AB174	86400	0.56	0.33	Large	Extraction	Poor	S/T Extraction Area
38AB010	25000	0.78	0.83	Large	Maintenance	Good	L/T Base Camp
38AB172	19500	0.78	0.67	Large	Maintenance	Good	L/T Base Camp
38AB130	10000	0.89	0.50	Large	Maintenance	Good	L/T Base Camp
38AB100	67500	0.67	0.33	Large	Maintenance	Poor	S/T Base Camp
38AB101	10000	0.67	0.17	Large	Maintenance	Poor	S/T Base Camp
38AB229	100	0.33	0.33	Small	Extraction	Poor	S/T Extraction Locus
38AB126	1	0.11	0.17	Small	Extraction	Poor	S/T Extraction Locus
38AB213	2800	0.78	0.50	Small	Maintenance	Good	L/T Logistical Camp
38AB149	2500	0.78	0.50	Small	Maintenance	Good	L/T Logistical Camp

Table 2: SIZGRP BY IVARGRP

SIZGRP IVARGRP

SIZGRP (Frequency / Expected / Deviation / Cell Chi2 / Percent / Row Pct / Col Pct)	Extraction	Maintenance	Total
Large	7	14	21
	9.1	11.9	
	-2.1	2.1	
	.467914	0.35497	
	13.73	27.45	41.18
	33.33	66.67	
	31.82	48.28	
Small	15	15	30
	12.9	17.1	
	2.1	-2.1	
	0.32754	.248479	
	29.41	29.41	58.82
	50.00	50.00	
	68.18	51.72	
Total	22	29	51
	43.14	56.86	100.00

STATISTICS FOR TABLE OF SIZGRP BY IVARGRP

Statistic	DF	Value	Prob
Chi-Square	1	1.399	0.237

Sample Size = 51

Table 3: SIZGRP BY IMATGRP

SIZGRP — IMATGRP

Frequency / Expected / Deviation / Cell Chi2 / Percent / Row Pct / Col Pct	Good	Poor	Total
Large	14 11.5 2.5 .529412 27.45 66.67 50.00	7 9.5 -2.5 .644501 13.73 33.33 30.43	21 41.18
Small	14 16.5 -2.5 .370588 27.45 46.67 50.00	16 13.5 2.5 .451151 31.37 53.33 69.57	30 58.82
Total	28 54.90	23 45.10	51 100.00

STATISTICS FOR TABLE OF SIZGRP BY IMATGRP

Statistic	DF	Value	Prob
Chi-Square	1	1.996	0.158

Sample Size = 51

Table 4: IMATGRP BY IVARGRP

IMATGRP — IVARGRP

Frequency / Expected / Deviation / Cell Chi2 / Percent / Row Pct / Col Pct

IMATGRP		Extraction	Maintenance	Total
Good	Frequency	5	23	28
	Expected	12.1	15.9	
	Deviation	-7.1	7.1	
	Cell Chi2	4.14824	3.14694	
	Percent	9.80	45.10	54.90
	Row Pct	17.86	82.14	
	Col Pct	22.73	79.31	
Poor	Frequency	17	6	23
	Expected	9.9	13.1	
	Deviation	7.1	-7.1	
	Cell Chi2	5.05003	3.83106	
	Percent	33.33	11.76	45.10
	Row Pct	73.91	26.09	
	Col Pct	77.27	20.69	
Total		22	29	51
		43.14	56.86	100.00

STATISTICS FOR TABLE OF IMATGRP BY IVARGRP

Statistic	DF	Value	Prob
Chi-Square	1	16.176	0.000

Sample Size = 51

Table 5: GROUP BY SITETYP

GROUP SITETYP

Frequency / Percent / Row Pct / Col Pct	Long-Term Extrct Area	Short-Term Extrct Area	Long-Term Base Camp	Short-Term Base Camp	Total
Group 1	1	2	1	0	12
	1.96	3.92	1.96	0.00	23.53
	8.33	16.67	8.33	0.00	
	33.33	50.00	9.09	0.00	
Group 2	0	0	2	0	6
	0.00	0.00	3.92	0.00	11.76
	0.00	0.00	33.33	0.00	
	0.00	0.00	18.18	0.00	
Group 3	1	0	0	1	8
	1.96	0.00	0.00	1.96	15.69
	12.50	0.00	0.00	12.50	
	33.33	0.00	0.00	33.33	
Group 4	0	1	2	0	7
	0.00	1.96	3.92	0.00	13.73
	0.00	14.29	28.57	0.00	
	0.00	25.00	18.18	0.00	
Group 5	1	0	3	0	8
	1.96	0.00	5.88	0.00	15.69
	12.50	0.00	37.50	0.00	
	33.33	0.00	27.27	0.00	
Group 6	0	1	3	2	10
	0.00	1.96	5.88	3.92	19.61
	0.00	10.00	30.00	20.00	
	0.00	25.00	27.27	66.67	
Total	3	4	11	3	51
	5.88	7.84	21.57	5.88	100.00

(Continued)

TABLE 5: GROUP BY SITETYP, continued.

GROUP / Frequency / Percent / Row Pct / Col Pct	SITETYP: Long-Term Extrct Locus	Short-Term Extrct Locus	Long-Term Logist Camp	Short-Term Logist Camp	Total
Group 1	2 3.92 16.67 100.00	4 7.84 33.33 30.77	2 3.92 16.67 16.67	0 0.00 0.00 0.00	12 23.53
Group 2	0 0.00 0.00 0.00	2 3.92 33.33 15.38	2 3.92 33.33 16.67	0 0.00 0.00 0.00	6 11.76
Group 3	0 0.00 0.00 0.00	2 3.92 25.00 15.38	2 3.92 25.00 16.67	2 3.92 25.00 66.67	8 15.69
Group 4	0 0.00 0.00 0.00	3 5.88 42.86 23.08	1 1.96 14.29 8.33	0 0.00 0.00 0.00	7 13.73
Group 5	0 0.00 0.00 0.00	0 0.00 0.00 0.00	3 5.88 37.50 25.00	1 1.96 12.50 33.33	8 15.69
Group 6	0 0.00 0.00 0.00	2 3.92 20.00 15.38	2 3.92 20.00 16.67	0 0.00 0.00 0.00	10 19.61
Total	2 3.92	13 25.49	12 23.53	3 5.88	51 100.00

Table 6: BOUNDARY BY RIDGE

BOUNDARY RIDGE

Frequency / Expected / Deviation / Cell Chi2 / Percent / Row Pct / Col Pct	Non-Ridge Cells	Ridge Cells	Total
Non-Boundary Cells	34859	3320	38179
	34855.2	3323.8	
	3.8	-3.8	
	.000408	.004282	
	90.05	8.58	98.63
	91.30	8.70	
	98.64	98.52	
Boundary Cells	481	50	531
	484.8	46.2	
	-3.8	3.8	
	.029356	.307848	
	1.24	0.13	1.37
	90.58	9.42	
	1.36	1.48	
Total	35340	3370	38710
	91.29	8.71	100.00

STATISTICS FOR TABLE OF BOUNDARY BY RIDGE

Statistic	DF	Value	Prob
Chi-Square	1	0.342	0.559

Sample Size = 38710

Table 7: BOUNDARY BY STREAM, INCLUDING SAVANNAH RIVER

BOUNDARY STREAM

Frequency / Expected / Deviation / Cell Chi2 / Percent / Row Pct / Col Pct	Rank One Stream	Rank Two Stream	Rank Three Stream	Savannah River	Land Cells	Total
Non-Boundary Cells	2431	731	399	636	38880	43077
	2418.2	747.8	399.1	689.5	38822.4	
	12.8	-16.8	-0.1	-53.5	57.6	
	.067843	0.37664	.000016	4.1513	.085327	
	5.57	1.68	0.91	1.46	89.16	98.78
	5.64	1.70	0.93	1.48	90.26	
	99.31	96.57	98.76	91.12	98.93	
Boundary Cells	17	26	5	62	421	531
	29.8	9.2	4.9	8.5	478.6	
	-12.8	16.8	0.1	53.5	-57.6	
	5.5037	30.5546	.001321	336.771	6.92207	
	0.04	0.06	0.01	0.14	0.97	1.22
	3.20	4.90	0.94	11.68	79.28	
	0.69	3.43	1.24	8.88	1.07	
Total	2448	757	404	698	39301	43608
	5.61	1.74	0.93	1.60	90.12	100.00

STATISTICS FOR TABLE OF BOUNDARY BY STREAM

Statistic	DF	Value	Prob
Chi-Square	4	384.434	0.000

Sample Size = 43608

Table 8: BOUNDARY BY STREAM

BOUNDARY STREAM

Frequency / Expected / Deviation / Cell Chi2 / Percent / Row Pct / Col Pct	Rank One Stream	Rank Two Stream	Rank Three Stream	Land Cells	Total
Non-Boundary Cells	2431	731	399	38880	42441
	2421.2	748.7	399.6	38871.4	
	9.8	-17.7	-0.6	8.6	
	.039312	.419666	.000855	.001882	
	5.67	1.70	0.93	90.61	98.91
	5.73	1.72	0.94	91.61	
	99.31	96.57	98.76	98.93	
Boundary Cells	17	26	5	421	469
	26.8	8.3	4.4	429.6	
	-9.8	17.7	0.6	-8.6	
	3.55748	37.9766	.077328	.170348	
	0.04	0.06	0.01	0.98	1.09
	3.62	5.54	1.07	89.77	
	0.69	3.43	1.24	1.07	
Total	2448	757	404	39301	42910
	5.70	1.76	0.94	91.59	100.00

STATISTICS FOR TABLE OF BOUNDARY BY STREAM

Statistic	DF	Value	Prob
Chi-Square	3	42.243	0.000

Sample Size = 42910

APPENDIX B: CREATING THE MAP OVERLAYS

Appendix B contains a brief summary of the GIS steps used to create each of the fourteen map overlays included in the body of the thesis. The format for the summary is as follows: 1) Map Overlay titles are printed in **Bold Underline**; 2) MapCgi commands are printed in **Bold**; 3) Intermediate map overlay names are printed in Underline.

Map 1: Late Archaic Sites in the Russell Reservoir Area

1. Site UTM's were obtained from the state site files at the South Carolina Institute of Archaeology and Anthropology, and a file of observation numbers and UTM coordinates was created.

2. **Plpmap** Sites as Points X 334000 y 3760000 for SiteMast v.

3. Elevation data was provided by the University of South Carolina Computer Services Division and the Humanities and Social Sciences Computing Laboratory.

4. **Plpmap** Elevation as points x 334000 y 3760000 for Eleva v.

5. **Renumber** Eleva assigning 1 to 1 through 300 for Cookie. (Cookie) is an overlay used to "cut out" areas outside the project area, and to provide an overlay for showing the rectangular project area.

6. **Renumber** Cookie assigning 7 to 1 for X.

7. **Renumber** SiteMast assigning 15 to 1 through 52 for Site15.

8. **Cover** X with Site15 for **ProjArea**.

9. **Label ProjArea.**

Map 2: Rivers and Streams in the Project Study Area

1. Hydrology features were digitized as separate layers for each stream rank, from U.S.G.S. 1:100,000 Abbeville and Clark Hill Lake map sheets.

2. **Plpmap** River as Line X 334000 Y 3760000 for River v.

3. **Plpmap** Rank3 as Line X 334000 Y 3760000 for Rank3 v.

4. **Plpmap** Rank2 as Line X 334000 Y 3760000 for Rank2 v.

5. **Plpmap** Rank1 as Line X 334000 Y 3760000 for Rank1 v.

6. **Cover** Cookie w Rank1 w Rank2 w Rank3 w Riverfor X.

7. **Renumber** X assigning 7 to 1 for **HydroP4**.

8. **Label HydroP4.**

Map 3: **Project Area Topography**

1. **Slice** Eleva into 7 for **Elevatn**.
2. **Label Elevatn.**

Map 4: **Project Area Slope Values (First Derivative of Elevation)**

1. **Differentiate** Eleva for X.
2. **Add** Cookie to X for **Slope7**. (increase values by one for display purposes.)
3. **Label Slope7.**

Map 5: **Terrain Roughness (Movement Impedance - 2nd Derivative of Elevation)**

1. **Subtract** Cookie from **Slope7** for X. (see Map 4.2 above).
2. **Differentiate** X maximally for X.
3. **Add** Cookie to X for **Rough**.
4. **Renumber Rough** assigning 7 to 1 for **Rough**.
5. **Label Rough.**

Map 6: **Site Types Based on Tool & Raw Material Variability, and Site Size**

1. See Chapter V for explanation of site types, and Appendix A for a list of sites of each type. Each of the eight types was assigned a number from one to eight, and read into the GIS with the command:

   Plpmap SiteType as Points X 334000 y 376000 for SiteType v.

2. **Renumber** Cookie assigning 7 t 1 for X.
3. **Add** X to Sitetype for **Sitetyps**.
4. **Label Sitetyps.**

Map 7: **Distance from Base Camps, Over Rough Terrain and Through Hydrology**

1. **Renumber** SiteType assigning 0 to 1 through 2 assigning 0 to 5 through 8 for X.
2. **Renumber Rough** assigning 0 to 7 assigning 1 to 2 for Steep.
3. **Spread** X to 200 through Steep over Eleva for **BaseCamp**.

4. **Slice** __BaseCamp__ into 25 for __BaseCamp__. (Making one kilometer increments of distance)

5. **Label** __BaseCamp__.

6. **Print** __BaseCamp__.

Map 8: __Thiessen Polygon Boundaries Based on Distance from Base Camps__

1. The boundary lines were drawn by hand from the hard copy of step 7.6 above, and digitized as both lines and polygons.

2. **Plpmap** BoundLn as Line X 334000 Y 3760000 for __Boundary__.

3. **Cover** __Cookie__ with __Boundary__ for __Boundary__.

4. **Renumber** __Boundary__ assigning 7 to 0 assigning 8 to 1 for __Boundary__.

5. **Label** __Boundary__.

Map 9: __Late Archaic Minimum Band (Subsistence Group) Habitual Use Areas__

1. **Plpmap** Areas as Polygon X 334000 y 3760000 for __Polys__.

2. **Label** __Polys__.

Map 10: __Site Types Distributed in Minimum Band Habitual Use Areas__

1. **Renumber** __Boundary__ assigning 0 to 7 assigning 1 to 8 for __X__.

2. **Cover** __Sitetyps__ with __X__ for __SiteArea__.

3. **Label** __SiteArea__.

Map 11: __Interaction Centers Along Boundaries of Habitual Use Areas__

1. **Export** __SiteArea__ for ASCII.

2. Edit Z values of exported map layer, drawing boxes around designated areas. Reformat result for reading into MapCgi.

3. **Read** from __BoundCtr__.

4. Label __BoundCtr__.

Map 12: **Site Distribution on Project Area Streams and Rivers**

1. **Renumber** Sitemast assigning 4 to 1 through 52 for X.
2. **Cover** **HydroP4** with X for **SitesH2O**.
3. **Label** **SitesH2O**.

Map 13: **Habitual Use Area Boundary Cells Intersecting Hydrology Cells**

1. **Renumber** **HydroP4** assigning 1 to 8 assigning 2 to 9 assigning 3 to 10 assigning 4 to 11 for **H2OBound**.
2. **Renumber** **Boundary** assigning 0 to 7 assigning 7 to 8 for X.
3. **Add** X to **H2OBound** for **H2OBound**.
4. **Renumber** **H2OBound** assigning 5 to 14 for **H2OBound**.
5. **Label** **H2OBound**.

Map 14: **Habitual Use Area Boundary Cells Intersecting Ridgetop Cells**

1. **Profile** Eleva north for PfN.
2. **Renumber** PfN assigning 0 to 1 th 2 assigning 0 to 4 through 9 for PfN.
3. **Profile** Eleva northeast for PfNE.
4. **Renumber** PfNE assigning 0 to 1 th 2 assigning 0 to 4 through 9 for PfNE.
5. **Profile** Eleva east for PfE.
6. **Renumber** PfE assigning 0 to 1 th 2 assigning 0 to 4 through 9 for PfE.
7. **Profile** Eleva southeast for PfSE.
8. **Renumber** PfSE assigning 0 to 1 th 2 assigning 0 to 4 through 9 for PfSE.
9. **Profile** Eleva south for PfS.
10. **Renumber** PfS assigning 0 to 1 th 2 assigning 0 to 4 through 9 for PfS.
11. **Profile** Eleva southwest for PfSW.
12. **Renumber** PfSW assigning 0 to 1 th 2 assigning 0 to 4 through 9 for PfSW.
13. **Profile** Eleva west for PfW.
14. **Renumber** PfW assigning 0 to 1 th 2 assigning 0 to 4 through 9 for PfW.

15. **Profile** Eleva northwest for PfNW.

16. **Renumber** PfNW assigning 0 to 1 th 2 assigning 0 to 4 through 9 for PfNW.

17. **Add** PfN to PfNE to PfE to PfSE to PfS to PfSW to PfW to PfNW for **RidgChek.**

18. **Renumber RidgChek** assigning 1 to 3 for **RidgChek.**

19. **Renumber Boundary** assigning 4 to 7 for X.

20. **Add RidgChek** to X for **Ridgchek.**

21. **Label RidgChek.**

Map 15: The Late Archaic Social Landscape in the Savannah River Valley

1. **Renumber Ridgchek** assigning 0 to 4 assigning 1 to 5 for X.

2. **Renumber Hydrop4** assigning 0 to 7 assigning 15 to 8 through 11 for Hydro15.

3. **Cover Polys** with Hydro15 with X for **Landscap.**

4. **Label Landscap.**

APPENDIX C: MAPUTIL.BAS -- THE MAP ANALYSIS PACKAGE EXTERNAL UTILITIES PROGRAM

MapUtil.Bas - The Map Analysis Package External Utilities Program

Data can be read into the Map Analysis Package Geographic Information System via a command called "PLPmap" (Point, Line, or Polygon map). Using this command, spatially referenced data, having a Z value representing some map theme, and UTM coordinates as X and Y values, may be imported into the GIS as point, line, or polygon data.

Each Late Archaic site in the Russell Reservoir was read into the GIS via a UTM recorded in the State Site Files at the South Carolina Institute of Archaeology and Anthropology. The UTM coordinates represented the centers of the sites, and were imported as point data.

One problem with the Map Analysis Package is that when this operation is performed, the user loses the link between the site number and the row and column number assigned to it in the GIS. There is no reporting mechanism to inform the user that site number 200 was located at row 12 and column 147, for example. This problem has been noted before (Savage 1988) in working with the Map Analysis Package.

This becomes more of a problem when the user is building a data set for subsequent statistical analysis. Data that is external to the GIS (for example, in this case, the site size and the artifact inventories) cannot be matched up with new variables created inside the GIS, because the user does not know which point in the GIS data layers refers to which site.

The Map Analysis Package External Utilities (Copyright 1989, Stephen H. Savage) program was created to allow the user to regain control of the variables inside the GIS, and create an external data file for reporting and analysis purposes.

There are three major steps involved in this process: 1) create a base file with row and column values from the site distribution; 2) open a created database file for subsequent processing; 3) add values to the database file from new map overlays created in the GIS.

The first of these steps works by assigning a unique observation number to each site when it is read into the Map Analysis Package via the PLPmap option described above. The observation value will be retained as the Z value in a map overlay containing only site locations, although the actual UTM coordinates will have been lost. (The UTM coordinates would, if the problem with MAP did not exist, form the best way to connect an external site number to an internal row and column designation.) Once this map overlay has been created, it is exported from the MAP program via the Export command, resulting in an ASCII file, which is used in the utilities program.

The utilities program reads the exported map overlay and records all the non-zero values (the site observation numbers) and their row and column designations. The three values become the foundation for the external database file, to which subsequent variables are added. The database management screen that is a part of the utilities program has a field on it for the actual site number, which the user must match up with the observation number as imported into MAP.

The second step in the process involves simply opening a designated database file for further processing. Since any number of database files could be created from each MAP database, this step is required.

Adding new variables to the file is accomplished by first making the desired map overlay inside the GIS (an example would be creating a Slope layer by differentiating Elevation). At this point,the user wants to determine what the slope value actually is at the site location in the database. The new Slope overlay is exported from the Map Analysis Package, and the Add Variables to Flat File option is run in the utilities program.

The utilities program reads the list of row and column values created during the initial step in the process (the create database step) and then pulls the Z values out of the new overlay at the points designated in the database file. These new values (Slope, in the example) are added to the database file as a separate variable. Subsequent references to the Database Management Screen will include the new variable. Up to 57 new variables may be created in this way. As each variable is created and named, it will appear in the "Variables" window on the main utilities screen, shown below.

Two other features of the utilities program allow creation of specialized variables which cannot easily be done inside the Map Analysis Package. The first is a "Closest Feature Value". Distances from features can be determined via the Spread command in MAP, and the Add Values function in the utilities program, described above. If, though, the exact location of the closest point is desired, or the values of the feature at the closest point, the information cannot be retrieved via MAP.

This function calculates the closest distance between each "seed" point in the database file, and records its row, column, and value. In this way it would be possible, for example, to determine the difference in elevation between a set of sites and the nearest water source.

The second additional feature allows the calculation of the Nth Nearest Neighbor to each location in the database file, based on Euclidean distance.

The data entry screens associated with the Map Analysis External Utilities Program are listed below along with on-line help screens that explain its functioning to the user, and descriptions of each data entry field in the two data entry screens. MapUtil.Exe is written in IBM Compiled Basic. It uses two random files for storing the flat database files and key values, a third for storing variable names, and a forth random file containing screen images and data entry field parameters. These parameters are given in the FormEdit Data Field Listing, included below. (FormEdit is Copyrighted 1986 by Stephen H. Savage.)

For this thesis, the MapUtil program was used to extract distances from sites to the nearest water sources (Savannah River, Ranks 1, 2 and 3 streams, and stream confluences), elevation, slope, aspect (slope face direction), the elevation of the nearest water source, and the four nearest neighbors to each site. This information is included as Appendix D: Additional Site Data.

```
M A P   A N A L Y S I S   P A C K A G E   E X T E R N A L   U T I L I T I E S

+--------------------------+ +----------------------------+----------------+
F1    Create Base File      | F2       Open Base File      | Variable Names |
+--------------------------+ +----------------------------+----------------+
| Map Overlay ++++++++++++ | | Base File Name ++++++++++++ |                |
| Output File ++++++++++++ | +----------------------------+                |
| Number of Rows       +++ | +--------------------------+ |                |
| Number of Columns    +++ | F3 Add Values to Base File | |                |
| Delete Map Overlay?    + | +--------------------------+ |                |
+--------------------------+ | Map Overlay ++++++++++++ | |                |
+--------------------------+ | Variable ++++++++++++++++ | |                |
F4 Closest Feature Value   | | Number of Rows       +++ | |                |
+--------------------------+ | Number of Columns    +++ | |                |
| Map Overlay ++++++++++++ | | Delete Map Overlay?    + | |                |
| Variable +++++++++++++++ | +--------------------------+ |                |
| Search Range         +++ | +--------------------------+ |                |
| Number of Rows       +++ | F5 Find Nearest Neighbors  | |                |
| Number of Columns    +++ | +--------------------------+ |                |
| Delete Map Overlay?    + | | Nth Nearest Neighbor   ++ | |                |
+--------------------------+ | Map Overlay Scale    ++++ | + <Pg Up><Pg Down> +
                             +--------------------------+


1CREATE 2 OPEN  3 ADD  4 FEAT. 5 NEAR  6 DATA  7      8      9 GO!  10 HELP
```

FormEdit Field Data Listing   File Name:maputil.scr   Screen Number: 1

No.	Row	Col	Length	Selected	Unselected	Cursor	Message	Edit	Table	Flag
1	6	16	12	9	112	137	3	3	0	0
2	7	16	12	9	112	137	3	0	0	0
3	8	25	3	9	112	137	1	1	0	0
4	9	25	3	9	112	137	1	1	0	0
5	10	27	1	9	112	137	2	2	0	0
6	11	46	12	9	112	137	3	3	0	0
7	12	42	16	9	112	137	4	0	0	0
8	13	55	3	9	112	137	1	1	0	0
9	14	55	3	9	112	137	1	1	0	0
10	15	57	1	9	112	137	2	2	0	0
11	15	16	12	9	112	137	3	3	0	0
12	16	12	16	9	112	137	4	0	0	0
13	17	25	3	9	112	137	1	1	0	0
14	18	25	3	9	112	137	1	1	0	0
15	19	25	3	9	112	137	1	1	0	0
16	20	27	1	9	112	137	2	2	0	0
17	20	56	2	9	112	137	1	1	0	0
18	21	54	4	9	112	137	1	1	0	0
19	6	48	12	9	112	137	5	4	0	0

```
M A P   A N A L Y S I S   P A C K A G E   E X T E R N A L   U T I L I T I E S
+-------------------------+-- Database Management --+-------------------------+
| Site Number    ++++++++ |                   +++++ |                   +++++ |
| As variables are  +++++ |                   +++++ |                   +++++ |
| created, they are +++++ |                   +++++ |                   +++++ |
| displayed as five +++++ |                   +++++ |                   +++++ |
| digit numbers and +++++ |                   +++++ |                   +++++ |
| a variable name.  +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
|                   +++++ |                   +++++ |                   +++++ |
+-------------------------+-------------------------+----------- Search Mode -+

1 NEXT  2 PREV  3 MODE  4DELETE 5REPORT 6 ASCII 7REMOVE 8       9       10 HELP
```

FormEdit Field Data Listing   File Name:maputil.scr   Screen Number: 2

No.	Row	Col	Length	Selected	Unselected	Cursor	Message	Edit	Table	Flag
1	3	18	8	9	7	137	6	5	0	0
2	4	21	5	9	7	137	1	1	0	0
3	5	21	5	9	7	137	1	1	0	0
4	6	21	5	9	7	137	1	1	0	0
5	7	21	5	9	7	137	1	1	0	0
6	8	21	5	9	7	137	1	1	0	0
7	9	21	5	9	7	137	1	1	0	0
8	10	21	5	9	7	137	1	1	0	0
9	11	21	5	9	7	137	1	1	0	0
10	12	21	5	9	7	137	1	1	0	0
11	13	21	5	9	7	137	1	1	0	0
12	14	21	5	9	7	137	1	1	0	0
13	15	21	5	9	7	137	1	1	0	0
14	16	21	5	9	7	137	1	1	0	0
15	17	21	5	9	7	137	1	1	0	0
16	18	21	5	9	7	137	1	1	0	0
17	19	21	5	9	7	137	1	1	0	0
18	20	21	5	9	7	137	1	1	0	0
19	21	21	5	9	7	137	1	1	0	0
20	22	21	5	9	7	137	1	1	0	0
21	3	47	5	9	7	137	1	1	0	0
22	4	47	5	9	7	137	1	1	0	0

FormEdit Field Data Listing File Name:maputil.scr Screen Number: 2

No.	Row	Col	Length	Selected	Unselected	Cursor	Message	Edit	Table	Flag
23	5	47	5	9	7	137	1	1	0	0
24	6	47	5	9	7	137	1	1	0	0
25	7	47	5	9	7	137	1	1	0	0
26	8	47	5	9	7	137	1	1	0	0
27	9	47	5	9	7	137	1	1	0	0
28	10	47	5	9	7	137	1	1	0	0
29	11	47	5	9	7	137	1	1	0	0
30	12	47	5	9	7	137	1	1	0	0
31	13	47	5	9	7	137	1	1	0	0
32	14	47	5	9	7	137	1	1	0	0
33	15	47	5	9	7	137	1	1	0	0
34	16	47	5	9	7	137	1	1	0	0
35	17	47	5	9	7	137	1	1	0	0
36	18	47	5	9	7	137	1	1	0	0
37	19	47	5	9	7	137	1	1	0	0
38	20	47	5	9	7	137	1	1	0	0
39	21	47	5	9	7	137	1	1	0	0
40	22	47	5	9	7	137	1	1	0	0
41	3	73	5	9	7	137	1	1	0	0
42	4	73	5	9	7	137	1	1	0	0
43	5	73	5	9	7	137	1	1	0	0
44	6	73	5	9	7	137	1	1	0	0
45	7	73	5	9	7	137	1	1	0	0
46	8	73	5	9	7	137	1	1	0	0
47	9	73	5	9	7	137	1	1	0	0
48	10	73	5	9	7	137	1	1	0	0
49	11	73	5	9	7	137	1	1	0	0
50	12	73	5	9	7	137	1	1	0	0
51	13	73	5	9	7	137	1	1	0	0
52	14	73	5	9	7	137	1	1	0	0
53	15	73	5	9	7	137	1	1	0	0
54	16	73	5	9	7	137	1	1	0	0
55	17	73	5	9	7	137	1	1	0	0
56	18	73	5	9	7	137	1	1	0	0
57	19	73	5	9	7	137	1	1	0	0
58	20	73	5	9	7	137	1	1	0	0
59	21	73	5	9	7	137	1	1	0	0
60	22	73	5	9	7	137	1	1	0	0

Total Length > 303

M A P   A N A L Y S I S   P A C K A G E   E X T E R N A L   U T I L I T I E S

HELP SECTION

General Help -> This program is designed to allow extraction of data from map overlays built in MapCgi2. Data is added, column by column, in a base file that is created with the **<F1>** function. Data entry fields allow use of the **<Left and Right Arrow>** to move inside a field, and the **<Backspace>**, **<Ins>** and **<Del>** keys. The **<Up Arrow>** and **<Down Arrow>** keys allow movement between data fields in a program window. Program windows are selected by pressing one of the first s function keys, as labeled on the screen. The program automatically starts in **<F2> - Open DataBase File Mode**. Use the <F9>-GO key to actually begin reading the map matrix. Use the <Esc> key to "back out" of the program, one screen at a time. From the main program <Esc> terminates the program, from here, it goes to the main screen, and from subsequent help screens it comes back here.

```
+-------------------------------------------------------------------+
|                    Additional help is available.                  |
|           Press one of the function keys listed below for         |
|                 more specific help on that subject.               |
+-------------------------------------------------------------------+
| F1 -> Create Base File             F4 -> Closest Feature Value    |
| F2 -> Open Base File               F5 -> Find Nearest Neighbor    |
| F3 -> Add Values to Base File      F6 -> Database Management      |
+-------------------------------------------------------------------+
```

```
+--------------------------------------------+
| Press <Esc> to Return to the Main Program. |
+--------------------------------------------+
```

M A P   A N A L Y S I S   P A C K A G E   E X T E R N A L   U T I L I T I E S

HELP SECTION

F1 -> Create Base File This function should be used ONCE for each flat file to be created. It reads a map matrix and extracts a row and column number for each non-zero value in the map, and writes a flat file containing three columns of data in the format 999 999 99999. The data fields are row, column and value from the matrix. In this function, and all others which ask for a map overlay name, the map must have been Exported from the MapCgi2 program in EPPL format, by using the command "Export Mapname for EPPL". You can delete the map overlay when this option has finished to save space on the disk.

F2 -> Open DataBase File The program enters this mode automatically when it starts up, or you can access it via the <F2> Function Key. This option opens a database file that has already been created via the <F1> - Create Base File option. Use this mode to open any database file prior to running any of the other program options, such as adding values, or database management. If you wish to change databases, run this option. The old database will be closed, and the new one opened.

```
+-----------------------------------------------+
| Press <Esc> to Return to the Main Help Menu.  |
+-----------------------------------------------+
```

M A P   A N A L Y S I S   P A C K A G E   E X T E R N A L   U T I L I T I E S
HELP SECTION

F3 -> Add Values to Base File To add new values to the base file, follow these steps: 1) Export a MapCgi overlay in EPPL format. The map should contain data such as elevation, slope, or distance (created in MapCgi via Spread); 2) Start this program, and Open the desired Base File; 3) Press the <F3> function key and fill out the window; 4) Press <F9>. This option looks at each location in the Base File, and then reads that location in the Map Overlay you have exported from MapCgi. The values in the overlay locations corresponding to entries in the Base File will be added as a data column in the Base File, in a five digit 99999 format. The variable name you select will be entered in the list on the right side of the main screen. Delete the Map Overlay to avoid disk clutter.

F4 -> Distance to Feature To start this function, follow the steps described above, **substituting <F4> for <F3>**. This function performs a search for the nearest Non Zero value in a Map Overlay, using the row and column values in the Base File as "seed points" to begin the search. The Search Range field is used to specify the search radius in number of grid cells. The program begins with the seed cell, and searches outward in rings around the seed cell until a Non Zero value is found. That value is then added to the Base File, along with its location Row and Column values.

```
+-------------------------------------------+
| Press <Esc> to Return to the Main Help Menu. |
+-------------------------------------------+
```

M A P   A N A L Y S I S   P A C K A G E   E X T E R N A L   U T I L I T I E S
HELP SECTION

F5 -> Nearest Nth Neighbor Use this option to calculate the Euclidean distance between seed points in the Base File (No Map Overlay is required). Once the map scale has been entered, and the Nth order nearest neighbor specified, press the <F9> key. The program will calculate all the distances from each seed point to every other seed point, then sort the distances, and record the Nth value in the Base File. The variable name is automatically assigned as "Nth Neighbor".

F6 -> Database Management To start this function, press the <F6> key. The Database Management screen will be displayed. Note that there is a field in the top left column for Site Number. When the <F1> option is run to create a new Base File, non zero values will be recorded, but they are not associated with an actual site number. Match the first value field manually with a Site Number, and enter the associated Site Number in the field. Use <F1> and <F2> to move to the next or previous record in the file. Use the <F3> - Mode key to select from **SEARCH**, **CHANGE**, or **ADD** modes (to find records, change their values, or add new seed points to the Base File). Use the <F4> - Delete key to delete an entry, or the <F7> - Remove key to remove one field from all the records. <F5> produces a printed report, and <F6> makes an ASCII Disk File that can be imported into Word Processors, Statistics Programs, Spreadsheets, or other Data Base Programs.

```
+-------------------------------------------+
| Press <Esc> to Return to the Main Help Menu. |
+-------------------------------------------+
```

APPENDIX D: ADDITIONAL SITE DATA

Appendix D: Additional Site Data (Sorted by Site Size)

Site # RivDis N1Site N3Site	Size R1Dis N1Size N3Size	State R2Dis N1Dis N3Dis	View R3Dis N2Site N4Site	Slope ForkDis N2Size N4Size	Aspect H2ODis N2Dis N4Dis	Elev H2OElev Easting Northing
09EB092	140000	G	58	5	7	425
889	762	2286	127	508	127	475
09EB204	1800	680	09EB208	45000	824	346500
09EB219	11250	874	09EB218	76500	1204	3772400
38AB077	100000	C	43	2	57	450
508	508	2286	3048	508	508	450
38AB288	400	654	38AB239	30000	912	346150
38AB078	5250	1507	09EB351	3000	1773	3777550
38AB174	86400	C	17	0	-1	600
2667	762	1524	1143	1270	762	475
38AB172	19500	610	38AB130	10000	2186	350525
38AB149	2500	2243	38AB101	10000	2576	3775050
09EB218	76500	G	47	3	0	475
1651	127	2413	381	381	127	450
09EB219	11250	380	09EB204	1800	1030	345600
09EB208	45000	1100	09EB092	140000	1204	3771600
38AB100	67500	C	138	0	-1	425
127	762	381	381	381	127	323
38AB101	10000	180	38AB126	1	1220	348800
38AB229	100	1716	38AB130	10000	1950	3772900
09EB208	45000	G	90	0	-1	425
508	254	2159	127	381	127	425
09EB092	140000	824	09EB219	11250	1012	346700
09EB218	76500	1100	09EB204	1800	1312	3771600
09EB276	40000	G	124	5	109	550
381	889	1016	1905	889	381	500
09EB281	1250	1444	09EB261	18000	1637	339050
38AN005	10000	2346	09EB388	1800	3409	3789200
09EB395	40000	G	79	6	180	500
1651	1778	0	4445	1905	0	500
09EB283	2250	1051	09EB285	7425	1258	338650
09EB286	1500	1463	09EB418	5625	1470	3784300

Appendix D: Additional Site Data (Sorted by Site Size)

Site #	Size	State	View	Slope	Aspect	Elev
RivDis	R1Dis	R2Dis	R3Dis	ForkDis	H2ODis	H2OElev
N1Site	N1Size	N1Dis	N2Site	N2Size	N2Dis	Easting
N3Site	N3Size	N3Dis	N4Site	N4Size	N4Dis	Northing
09EB058	30000	G	83	3	180	500
5334	381	254	3556	381	254	475
09EB063	2400	452	09EB057	5000	1710	338650
09EB056	3700	1952	09EB327	1875	4245	3775150
38AB239	30000	C	56	1	46	500
1270	635	1397	2159	1143	635	500
38AB078	5250	600	38AB077	100000	912	347050
38AB288	400	1261	09EB351	3000	2672	3777700
38AB089	26000	C	120	2	90	500
6096	762	2540	127	254	127	425
38AB119	7500	2325	38AB114	13000	2550	349600
38AB078	5250	4812	38AB274	400	4875	3782100
38AB010	25000	C	84	7	164	400
127	254	1651	2921	381	127	325
38AB213	2800	559	38AB229	100	1222	349975
38AB126	1	1979	38AB130	10000	2689	3770300
38AB172	19500	C	125	4	23	525
2667	635	1016	508	635	508	400
38AB174	86400	610	38AB149	2500	2178	350175
38AB130	10000	2736	38AB101	10000	2806	3775550
09EB261	18000	G	76	2	90	500
127	381	508	3302	381	127	475
38AN005	10000	743	09EB281	1250	965	339400
09EB276	40000	1637	09EB388	1800	1802	3787600
38AB114	13000	C	90	3	180	500
4445	254	1524	127	645	127	475
38AB089	26000	2550	38AB078	5250	2724	349650
38AB239	30000	3191	38AB149	2500	3663	3779550
09EB219	11250	G	106	3	135	450
1524	254	2540	127	254	127	425
09EB218	76500	380	09EB204	1800	657	345750
09EB092	140000	874	09EB208	45000	1012	3771950

Appendix D: Additional Site Data (Sorted by Site Size)

Site #	Size	State	View	Slope	Aspect	Elev
RivDis	R1Dis	R2Dis	R3Dis	ForkDis	H2ODis	H2OElev
N1Site	N1Size	N1Dis	N2Site	N2Size	N2Dis	Easting
N3Site	N3Size	N3Dis	N4Site	N4Size	N4Dis	Northing
09EB366	10000	G	56	3	144	425
635	381	127	127	127	127	425
09EB328	1600	212	09EB327	1875	602	341500
09EB340	1875	982	09EB315	1200	3521	3778800
38AB101	10000	C	92	3	46	425
254	635	508	254	254	254	350
38AB100	67500	180	38AB126	1	1388	348900
38AB229	100	1845	38AB130	10000	1858	3773050
38AB130	10000	C	93	3	54	525
2032	381	762	1143	762	381	450
38AB101	10000	1858	38AB100	67500	1950	350750
38AB174	86400	2186	38AB229	100	2281	3772875
38AN005	10000	C	86	2	66	500
254	889	635	3937	635	254	475
09EB261	18000	743	09EB388	1800	1285	339810
09EB281	1250	1607	09EB276	40000	2346	3786980
09EB076	7500	G	89	9	83	375
127	127	3048	2032	508	127	325
09EB405	7500	474	09EB320	3000	672	346500
09EB204	1800	2198	38AB288	400	2240	3774700
09EB300	7500	G	127	0	-1	425
127	254	0	3048	127	0	425
09EB291	2500	403	09EB315	1200	1706	340200
09EB286	1500	1756	09EB418	5625	2002	3783000
09EB405	7500	G	108	2	65	525
508	381	3556	2159	1016	381	375
09EB320	3000	304	09EB076	7500	474	346050
38AB288	400	2050	09EB204	1800	2258	3774850
38AB119	7500	C	113	0	-1	575
8255	127	1270	635	635	127	550
38AB089	26000	2325	38AB274	400	2973	350650
38AB114	13000	4731	38AB136	2500	6626	3784175

Appendix D: Additional Site Data (Sorted by Site Size)

Site #	Size	State	View	Slope	Aspect	Elev
RivDis	R1Dis	R2Dis	R3Dis	ForkDis	H2ODis	H2OElev
N1Site	N1Size	N1Dis	N2Site	N2Size	N2Dis	Easting
N3Site	N3Size	N3Dis	N4Site	N4Size	N4Dis	Northing
09EB285	7425	G	101	2	172	525
2413	1524	762	3937	2413	762	475
09EB283	2250	325	09EB418	5625	585	337825
09EB286	1500	800	09EB395	40000	1258	3783350
09EB418	5625	G	143	2	0	575
2032	1016	889	3302	2032	889	500
09EB286	1500	254	09EB283	2250	477	338200
09EB285	7425	585	09EB395	40000	1470	3782900
38AB078	5250	C	77	0	-1	575
1778	1016	889	1524	1524	889	500
38AB239	30000	600	38AB077	100000	1507	347650
38AB288	400	1766	38AB114	13000	2724	3777700
09EB057	5000	G	107	2	109	475
5842	381	254	1905	635	254	450
09EB056	3700	250	09EB058	30000	1710	339700
09EB063	2400	2051	09EB327	1875	5093	3773800
09EB056	3700	G	118	2	162	475
5842	254	254	1651	381	254	475
09EB057	5000	250	09EB058	30000	1952	339900
09EB063	2400	2300	09EB327	1875	5197	3773650
09EB320	3000	G	61	7	52	500
381	635	3810	2540	1143	381	350
09EB405	7500	304	09EB076	7500	672	346000
38AB288	400	1751	09EB351	3000	2304	3775150
09EB351	3000	G	87	3	180	450
508	127	2032	3048	508	127	450
38AB288	400	1575	38AB077	100000	1773	344500
09EB320	3000	2304	09EB405	7500	2570	3776900
38AB213	2800	C	50	0	-1	425
127	762	1651	2540	889	127	425
38AB010	25000	559	38AB229	100	738	349475
38AB126	1	1460	38AB100	67500	2445	3770550

Appendix D: Additional Site Data (Sorted by Site Size)

Site #	Size	State	View	Slope	Aspect	Elev
RivDis	R1Dis	R2Dis	R3Dis	ForkDis	H2ODis	H2OElev
N1Site	N1Size	N1Dis	N2Site	N2Size	N2Dis	Easting
N3Site	N3Size	N3Dis	N4Site	N4Size	N4Dis	Northing
09EB291	2500	G	101	8	85	475
381	127	254	2794	381	127	425
09EB300	7500	403	09EB315	1200	1365	339850
09EB286	1500	1400	09EB418	5625	1653	3782800
38AB136	2500	C	83	3	56	525
10795	381	1651	127	508	127	525
38AB133	500	475	38AB274	400	3923	350525
38AB119	7500	6626	38AB089	26000	8749	3790800
38AB149	2500	C	158	8	54	625
4826	381	1016	1778	1016	381	500
38AB172	19500	2178	38AB174	86400	2243	352000
38AB114	13000	3663	38AB130	10000	4062	3776740
09EB063	2400	G	32	2	49	450
5588	381	127	3810	381	127	450
09EB058	30000	452	09EB057	5000	2051	338200
09EB056	3700	2300	09EB327	1875	4460	3775200
09EB283	2250	G	117	0	-1	525
2159	1524	635	3810	2159	635	475
09EB285	7425	325	09EB418	5625	477	338150
09EB286	1500	604	09EB395	40000	1051	3783375
09EB327	1875	G	94	5	50	475
1270	381	508	381	381	381	475
09EB328	1600	492	09EB366	10000	602	340900
09EB340	1875	1562	09EB315	1200	3224	3778750
09EB340	1875	G	61	6	135	450
381	889	762	508	508	381	375
09EB366	10000	982	09EB328	1600	1170	342450
09EB327	1875	1562	09EB351	3000	2631	3778550
09EB204	1800	G	113	2	173	500
1651	254	2667	127	127	127	500
09EB219	11250	657	09EB092	140000	680	345850
09EB218	76500	1030	09EB208	45000	1312	3772600

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Appendix D: Additional Site Data (Sorted by Site Size)

Site #	Size	State	View	Slope	Aspect	Elev
RivDis	R1Dis	R2Dis	R3Dis	ForkDis	H2ODis	H2OElev
N1Site	N1Size	N1Dis	N2Site	N2Size	N2Dis	Easting
N3Site	N3Size	N3Dis	N4Site	N4Size	N4Dis	Northing
09EB388	1800	G	122	1	135	500
381	1524	635	5080	635	381	475
38AN005	10000	1285	09EB395	40000	1634	339300
09EB261	18000	1802	09EB281	1250	2232	3785800
09EB328	4200(*)	G	84	2	147	425
762	508	254	127	381	127	425
09EB366	10000	212	09EB327	1875	492	341350
09EB340	1875	1170	09EB315	1200	3310	3778950
09EB286	1500	G	110	2	64	575
1778	762	889	3175	1778	762	525
09EB418	5625	254	09EB283	2250	604	338450
09EB285	7425	800	09EB291	2500	1400	3782850
09EB281	1250	G	170	0	-1	525
762	381	254	3302	254	254	500
09EB261	18000	965	09EB276	40000	1444	338475
38AN005	10000	1607	09EB388	1800	2232	3787875
09EB315	1200	G	104	2	117	525
1524	762	381	1651	1651	381	475
09EB291	2500	1365	09EB286	1500	1553	339300
09EB300	7500	1706	09EB418	5625	1741	3781550
09EB255	1000	G	98	0	-1	375
127	1270	635	3302	635	127	325
38AB010	25000	3333	38AB213	2800	3768	351200
38AB229	100	4505	38AB126	1	5209	3767200
38AB133	500	C	93	7	147	600
11176	254	1524	508	635	254	525
38AB136	2500	475	38AB274	400	4056	351000
38AB119	7500	6634	38AB089	26000	8811	3790800
38AB274	400	C	82	2	91	500
9525	1270	127	127	381	127	500
38AB119	7500	2973	38AB136	2500	3923	349650
38AB133	500	4056	38AB089	26000	4875	3786975

Appendix D: Additional Site Data (Sorted by Site Size)

Site #	Size	State	View	Slope	Aspect	Elev
RivDis	R1Dis	R2Dis	R3Dis	ForkDis	H2ODis	H2OElev
N1Site	N1Size	N1Dis	N2Site	N2Size	N2Dis	Easting
N3Site	N3Size	N3Dis	N4Site	N4Size	N4Dis	Northing
38AB288	9000(*)	C	82	5	120	425
127	127	2540	3175	127	127	450
38AB077	100000	654	38AB239	30000	1261	346075
09EB351	3000	1575	09EB320	3000	1751	3776900
38AB229	100	C	100	0	-1	525
635	1397	1016	2032	1270	635	325
38AB213	2800	738	38AB126	1	765	349175
38AB010	25000	1222	38AB100	67500	1716	3771224
38AB126	1	C	85	6	78	500
254	1397	254	1270	762	635	325
38AB229	100	765	38AB100	67500	1220	348575
38AB101	10000	1388	38AB213	2800	1460	3771700

Where:

View - Number of Grid Cells Visible from Center of Site
Slope - Slope Value in Degrees
Aspect - Degrees away from South (-1 - flat)
XXDis - Distance in Meters, from Center to Water, or Center to Center
XXXElev - Elevation n Feet above Mean Sea Level

(*) - Size Adjusted According to Testing Results Reported in Goodyear, Montieth and Harmon (1983).